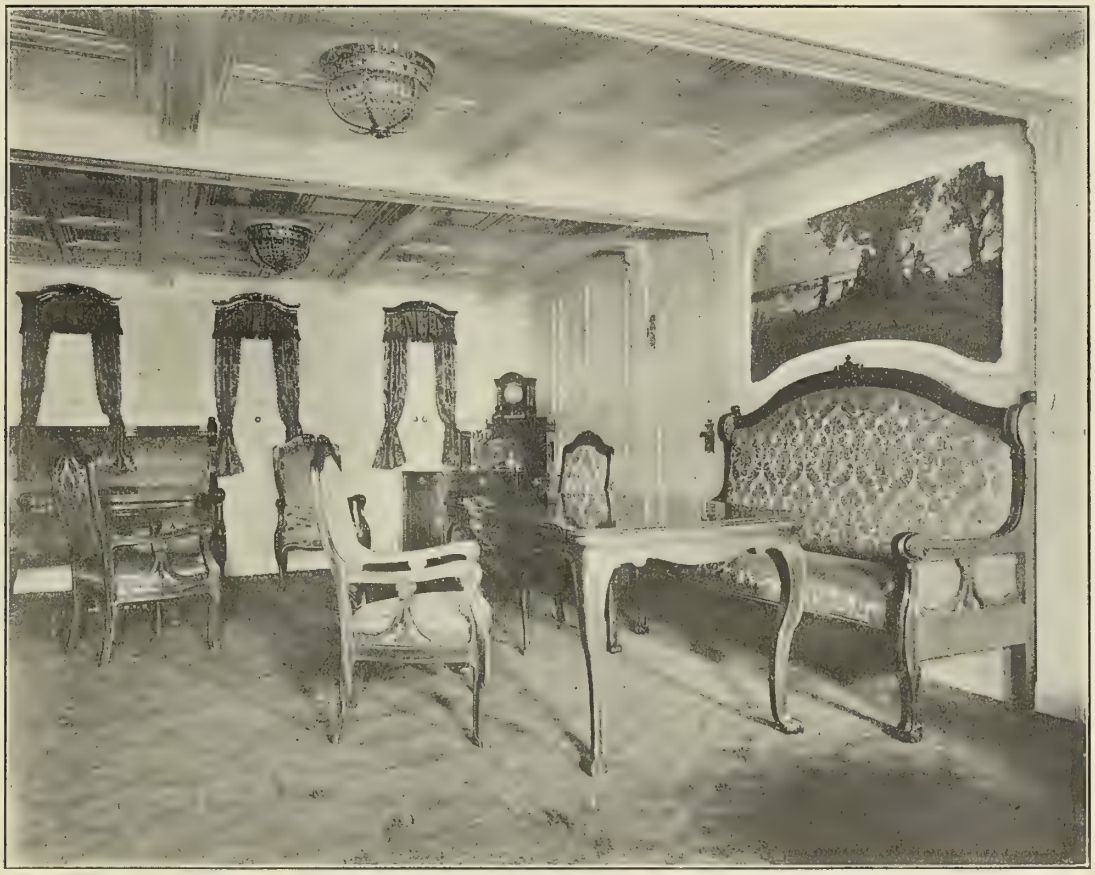
International Marine Engineering

MAY, 1908.

ELONGATION AND REBUILDING OF THE ROYAL DANISH STEAM YACHT DANNEBROG.

BY AXEL HOLM.

In November, 1906, the Danish Parliament voted the sum of Kroner 435,000 ($116,600 or £24,000) for the elongation and rebuilding of the royal steam yacht *Dannebrog** for King Frederik VII., and on November 19 the yacht was hauled on the slip of the navy yard at Copenhagen, and work commenced.



A CORNER OF THE DRAWING ROOM ON THE REMODELED DANISH ROYAL YACHT DANNEBROG.

The yacht was a comparatively old flush-decked paddle steamer, built in 1880 by the Burmeister & Wain's shipbuilding company, at Copenhagen; and as it was built of iron, there were professional objections, to the effect that it was not an economical use of the money to rebuild the ship, and not the work for a navy yard. It was said that it would be better to get an entirely new and modern yacht for the use of the king. But the parliament cut the matter short and sanctioned the elongation, and time has shown that this was not so bad after all. The yacht, as it now appears, finished, is a very nice little steamer, and the interior, most of which is worked out after the plans of architect Carl Brummer by the furnishing company (Otto Meyer, of Copenhagen), is as luxurious, tasteful and comfortable as it can be on board a ship of this small size.

Before and after the elongation, the *Dannebrog* was of the following dimensions:

	Before.	After.
Length between perpendiculars	192′	227′
Breadth molded	25′ 2″	26′ 2″
Breadth over guards	51′	51′
Depth molded	15′ 6″	15′ 6″
Draft	13′	0′ 10″

* The name of the Danish flag.

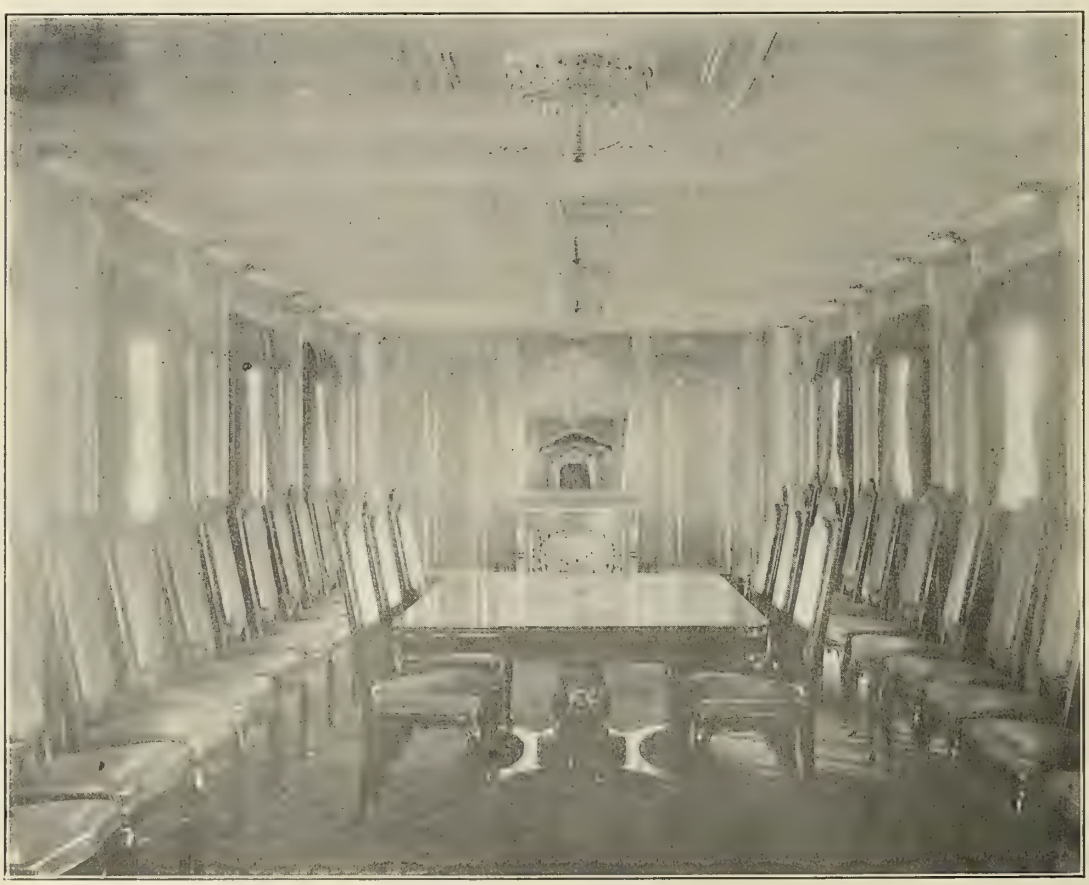
THE DANNEBROG, BEFORE RECONSTRUCTION, ANCHORED BEFORE RHEDEN.

	Before.	After.
Displacement	890 tons	1,063 tons
Block coefficient of fineness	0.625	0.7
Ratio, length to breadth	7.35	8.7
Ratio, length to depth	12.4	14.6
Gross register tonnage	740	852.7

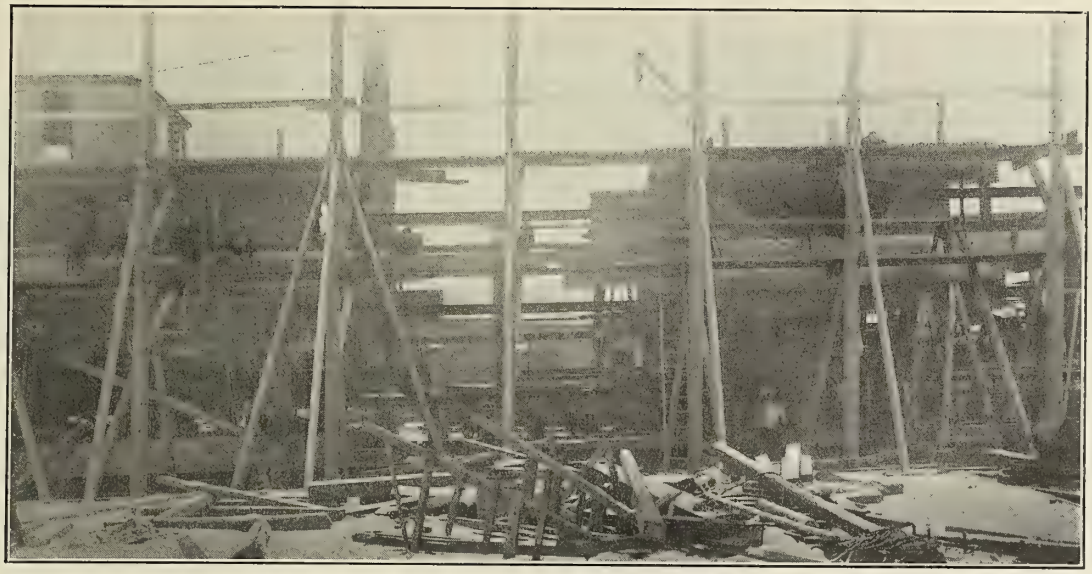
The contract price in 1880 was about Kroner 700,000 ($187,500, or £38,500), but this sum certainly was surpassed.

The engines were two compound oscillating sets, working independently of each other on two cranks. Each set consisted of a high-pressure cylinder 30 inches diameter, and a low-pressure cylinder 60 inches diameter surrounding the high pressure, with three piston rods, one for the high-pressure piston in the center, and two for the low-pressure on each side, connected at top by a cross-piece holding the crank-pin bearing. Steam was furnished by two common cylindrical marine boilers, 10 feet 3 inches diameter and 14 feet 2 inches length, besides one small donkey boiler.

As seen from the drawings, the elongation—35 feet—was provided at two places, one cut forward and the other aft of the wheel boxes, thus adding 17 feet to the space for the royal



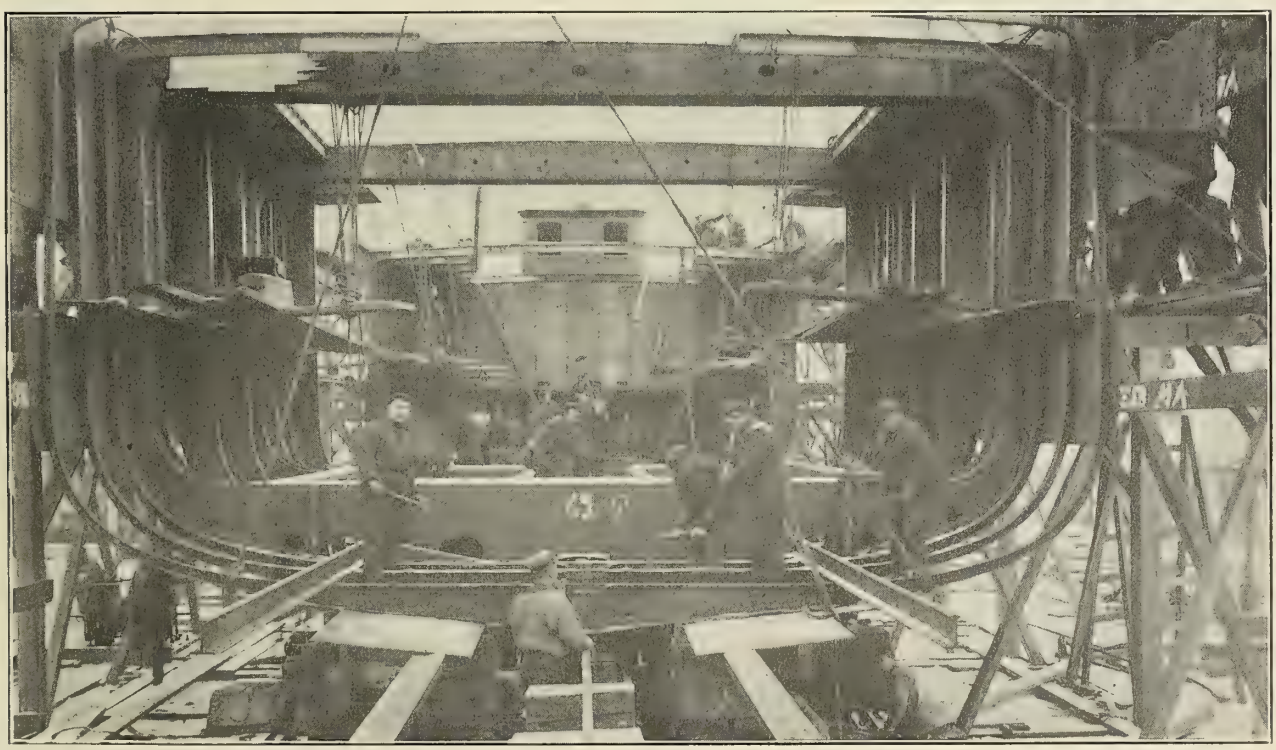
THE STATE DINING-ROOM ON THE ROYAL YACHT DANNEBROG.



THIS VIEW SHOWS THE CENTRAL PADDLE-WHEEL SECTION, THE AFTER SECTION, AND THE TWO GAPS TO BE FILLED IN.

family, 4 feet to the engine space, and 14 feet to the suites' rooms. The wheel boxes and the houses on guards were not enlarged, but, as shown, the interior was partially altered, while the large deck houses fore and aft were greatly enlarged and refurnished. Two new boilers were fitted, the dimensions being: length, 10 feet; diameter, 15 feet 6 inches; heating surface, 2,100 square feet; grate area, 62 square feet, and working pressure 75 pounds per square inch, with domes 5 feet high by 3 feet 6 inches diameter. The boilers work without forced draft. The old donkey boiler is still used. The old engines, with only small improvements, were again installed, as also the feathering paddle wheels, but the old wooden floats are substituted by iron ones 8 feet 6 inches by 2 feet 6 inches, twelve in number. The shaft diameter is 10¾ inches, and the wheels are 20 feet in diameter. The four coal bunkers contain a total of 108 tons. The fresh-water supply amounts to 4,900 gallons in three tanks, forward, amidships and aft. To the electrical plant, formerly consisting of an engine and dynamo of 115 amperes capacity, is added one of 80 amperes, the ship being now electrically lighted throughout. A powerful searchlight is installed, and the top and side lights are arranged for electricity. The entire plant was installed by the navy yard, as also the new wireless telegraph outfit.

Besides the alterations mentioned, none were undertaken except in the staterooms for the royal family, the suites and offices, all of which accommodations were renewed throughout. The late King Christian IX. was a plain and homely man, and he would not allow any expenditure on modernizing his yacht. "She is good enough for me," he said, and thus the accommodation, 26 years old, was more than antiquated and fully unfitted for use. As a matter of comparison, the only part of the accommodation aft still in use is the after end of

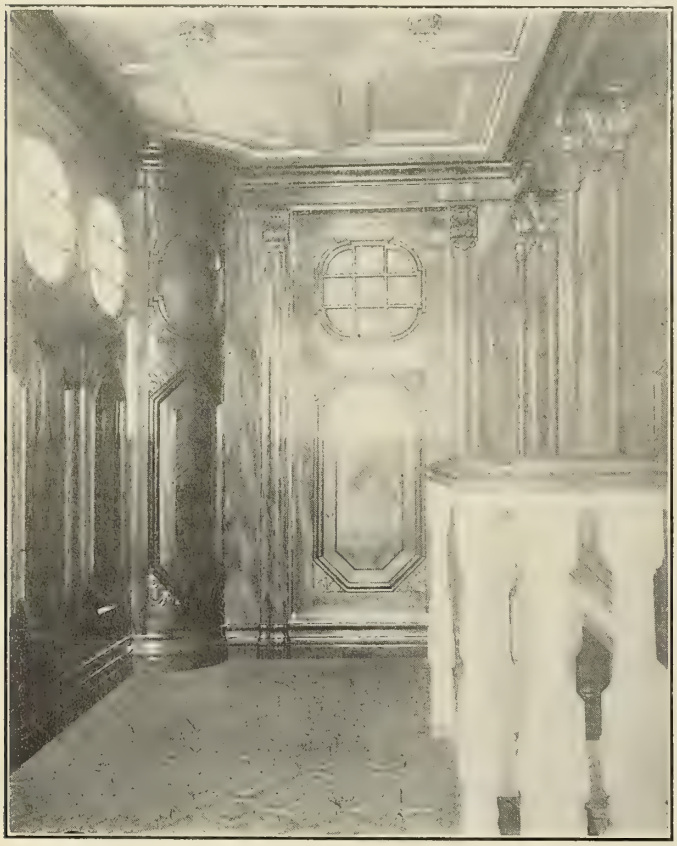


VIEW FROM THE FORWARD PORTION, SHOWING THE CENTRAL AND AFTER PORTIONS AND THE TWO GAPS TO BE FILLED IN.

the former saloon for the king, now serving as a room for maid servants.

Beginning with the bridge deck, we here find a little steam steering engine in front, and then, between the two funnels, are arranged a chart house and two glass-sheltered lounges or smoke rooms, with a flying bridge on top, and the teak engine skylight between. Aft are two comfortable, curved staircases down to the main deck, for the use of the royal family, and two others for the crew, forward. On this deck is also placed an apparatus for indicating revolutions of the engine, consisting of a complete model paddle wheel in a glass box, electrically connected with the shaft. No awning is carried over this deck, but the steering station in front is fitted in the usual manner with weather cloth and curtains of awning.

The main deck is laid in yellow pine with cemented gutter, and the bulwark plating, with teak rail, is paneled with wood



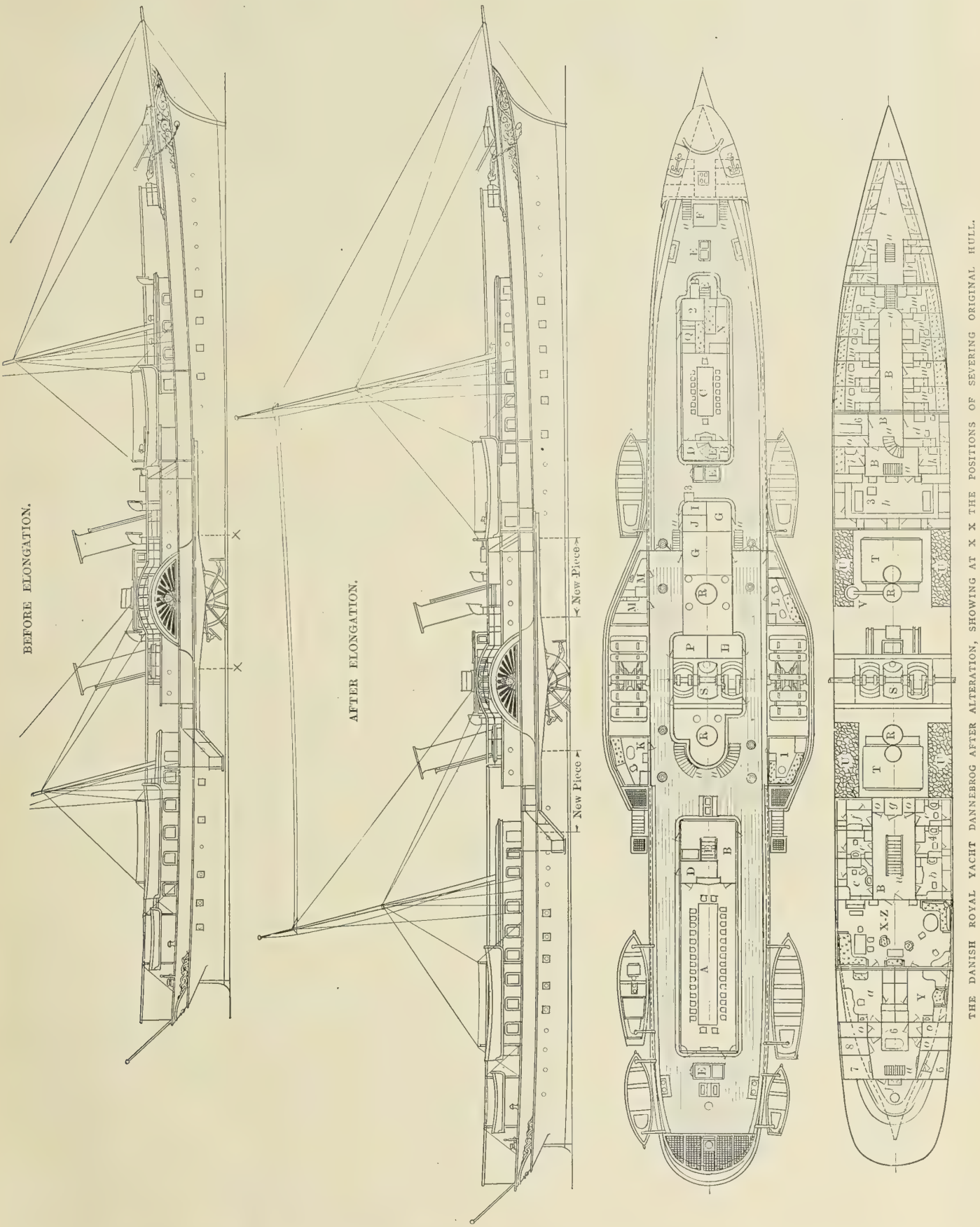
THE MAIN ENTRANCE HALL ON THE DANNEBROG.

all around inside. Forward, under the raised forecastle deck, on which are placed the two bowers with anchor crane and berths, are toilets and rooms for paints, oil, lamps and stores, besides a trunked skylight down to the crew's quarters. Just abaft the forecastle is a windlass of recent date, and companionway for the crew. The steel deck house then following measures 36 feet by 10 feet 6 inches, with the entrance and staircase down to the suites in front. This contains rooms for wireless telegraphy, first lieutenant and chief engineer, a roomy and tastefully fitted mess for officers, seating sixteen persons, separate entrance and staircase for a prince, and, finally, a pantry for officers. Aft of this house is a companionway for officials and servants, and a trunked ladder down to firemen's quarters. Then in the fore end of engine and boiler casing are arranged spaces for wine and china, a galley for crew, and a large, well-fitted galley for the court. Over the engine are placed the silver room, and stateroom for second engineer.

Iron-front bulkheads, with iron doors, are placed from the houses on the guards to the boiler casing, and over the coal bunkers are placed circular coal scuttles level with the deck, eight in number. On starboard guard, forward, is a toilet for officers, next the apartment for the ship's captain, and aft a large smoke-room for the king. This cozy room is carried out in pure white, the carved paneling being in dull white and the ceiling enameled; the furniture in dark mahogany with buff upholstery, and the dark brown carpets, form an agreeable contrast to the white walls and ceiling. In port guard are, forward of the wheel box, two rooms for the large galley, and, aft, an apartment for the king's flag captain. Aft of these houses are on both sides arranged the gangways and accommodation ladders.

The iron deck house aft measures 52 feet by 11 feet. On the front end of this is a teak skylight, with seats over the trunk hatch down to after hold, and inside are, first, the entrance and stairways down to the royal apartments. The entrance is an exceedingly tasteful space, as may be seen from the photograph, the paneling and pilasters being in elm wood, and the ceiling dull white. Over the staircase is placed a little skylight, and on the port side is a cozy sofa upholstered in yellow; the carpet is also yellow. From this entrance a glass door leads to the king's dining-room, this being particularly large, 37 feet by 11 feet, capable of seating thirty-four persons. It is fitted out in a very extraordinary manner. The paneling and ceiling are laid all over with silver, covered on the walls with a transparent blue color, the molds and the large square windows being framed by broad golden lists. The furniture in dark red mahogany, the red leather upholstery, the carmine red curtains and Smyrna carpet, form a bizarre and curious impression of great effectiveness. At the after end is a small sideboard over the radiator, and at the forward a larger buffet, with bronze lattice work in front; the latter is surmounted by an artistic relief in white and blue china. The hemispherical chandeliers, six in number, in the middle line, are artistically worked out with glass prisms in gilt metal. Two doors at the after end lead to the open, and between the saloon and the entrance is situated a roomy pantry. Aft of the house is a companionway for maids and servants, a skylight and a hand-driven capstan. Over the quadrant and tiller is a large wooden grating, and over the rudder head is mounted a spare steering gear. The six boats hang, as shown, outboard in davits all around the ship, the outfit consisting of one 25-foot steam launch, one pinnace of 28 feet and two of 25 feet, one 21-foot life boat and one 15-foot dinghy.

Under the main deck the hull is divided into seven watertight compartments by six bulkheads, of which two are new. Forward, between the first and second bulkheads on lower deck, are berthed crew and petty officers, the space being 28 feet in length, and beneath this deck are also arranged spare berths for crew. Then on the lower deck are located, in the next watertight compartment, ten large staterooms for the gentlemen of the court. The rooms are carried out all in the same manner, completely in dull white, the upholstery, carpets and curtains varying in colors with each room; the light ports are large and square, while steel coverings with circular glass are hinged outside. This compartment occupies 28 feet 6 inches in length, and the next 26 feet. Here is first arranged a separate accommodation for a prince, consisting of a sleeping room, bath, toilet and entrance with staircase to main deck. The sleeping room is carried out in the same tasteful manner as before mentioned for the suite. Then follow rooms for the king's cook, the quartermaster-sergeant, and, close to forward engine bulkhead, the servants' quarters. Under lower deck in this compartment are berthed the firemen, with passage to main deck by means of the trunked ladder, and to the engine room through a watertight door. The engines and boilers then take up 60 feet of the length. The living rooms



THE DANISH ROYAL YACHT DANNEBROG AFTER ALTERATION, SHOWING AT X X THE POSITIONS OF SEVERING ORIGINAL HULL.

A, Royal aining saloon. B, Entrances. C, Officers' messroom. E, Stairways, down. F, Windlass. G, Galley. H, Silver room. I, China closet. J, Wines. K, Flag captain. L, Ship's captain. M, Scullery. N, Officers. O, Toilet. P, Assistant engineer. Q, First engineer. R, Funnel and uptakes. S, Propelling engine. T, Main boilers. U, Coal bunkers. V, Donkey boiler. X, King's saloon. Y, King's sleeping room. Z, Queen's saloon. a, Queen's sleeping room. b, Crown prince. c, Crown princess. d, Prince. e, Ladies in attendance. f, Maid servants. g, Trunked hatch. h, Servants. i, Cook. k, Quartermaster-sergeant. l, Saloon. m, Gentlemen of the court. n, Wardrobe. p, Gunner. q, Carpenter. r, Petty officers. s, Boatswain. t, Crew. u, Stairways, up. 1, Smoking room. 2, Wireless telegraph. 3, Trunked ladder for firemen. 4, Princess. 5, Valet. 6, Bath rooms. 7, Queen's wardrobe. 8, King's wardrobe.

for the royal family occupy the remaining two compartments aft, measuring 38 and 44 feet, respectively.

Here is first the roomy entrance hall, in white all over, with the staircase to main deck, and doors opening to the royal saloon, to the staterooms for the crown prince and crown princess, to a room for a princess, two rooms for ladies in attendance, a room for two maid servants, as also to two toilets, and the trunk to space below. These staterooms are all carried out in the same manner as mentioned above for the suites and the prince forward. In the rooms for the crown prince and crown princess are small bath tubs arranged in the floor, covered with trap doors and the carpets, when not in use.

The royal saloon is a very attractive room. The walls are painted dull white, and the ceiling white enameled, the paneling and molds being covered with carved reliefs and lists. Opposite the swinging doors from the entrance hall is placed a great allegorical picture in a carved white frame, between the doors leading to the king's and queen's sleeping rooms, and on both sides of the swing doors are situated the steam radiators covered by small sideboards with marble tops, and mirrors over. The furniture is carried out in polished lemon wood, with upholstery in yellow damask.

In two corners, as shown, are arranged large sofas, tables and chairs. In another corner is a writing desk; a piano is also placed in this room, and under the large painting mentioned are a sofa, with table and arm chairs. The soft and delicate Smyrna carpet is yellow, and so are also the silk curtains for the square side lights. The illumination consists of three chandeliers as in the dining saloon, and several artistic metal standing lamps. As shown in photograph, the whole impression of this room is very agreeable, light and comfortable.

The doors from this saloon to the royal sleeping rooms lead through the after watertight bulkhead, and, hidden in the paneling, are here arranged two horizontal sliding watertight doors worked automatically from the main deck. These two sleeping rooms, being carried out both in polished elm, are almost identical, but the placing of the furniture, carpets and curtains, and color of upholstery, are varied. In the king's room the upholstery is in striped olive green silk, and in the queen's room in white and light blue, the color of carpets and silk curtains corresponding. The ceiling is white enameled, and the side lights are square. Over the king's berth is placed an old compass, arranged in a metal crown. It was given a long time ago to the late King Christian IX., by a fisherman.

Just abaft these rooms are situated a toilet on each side and a roomy bath amidships, and on the port side two large wardrobes for the royal use; another toilet for servants, a room for the king's valet, and finally the above-mentioned room for the queen's maid servants, in the end of the former royal saloon.

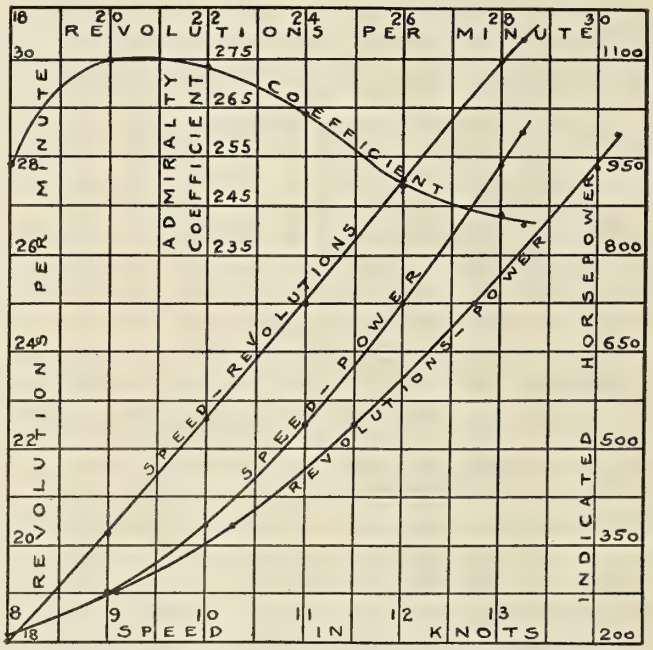
The heating is by steam throughout, and in every watertight compartment is placed an electric fan, taking the heavy air at the floor, the new air coming in at the ceiling through downcast ventilators. The spaces below lower deck, where not otherwise mentioned, are used for stores, provisions, wines and water tanks; while a mess room for petty officers and officials is arranged forward.

The two old schooner masts are again used, but, while formerly carried through the deck houses to main deck, they are now placed in sockets on the tops of the houses. Awnings are carried all fore and aft over main deck. The hull is black painted, with gilt carved ornamentals fore and aft, as also on the wheel boxes, the deck erections being white throughout. The whole appearance of the little craft is very handsome, and as it is intended for navigation only on the closed waters among the Danish "hundred islands," it is well fitted for its purposes.

Finally we have the results of the 4-hour trial trip in August, 1907, and the indicated horsepower for varying speeds, viz:

Draft forward	9 feet 6 inches
Draft aft (mean 9 feet 10½ inches)	10 feet 3 inches
Displacement	1,063 tons
Speed in knots	13.04
Admiralty coefficient	246.
Revolutions per minute	30.0
Slip in percent	22.08
Boiler pressure, pounds per square inch	75.5
Vacuum in inches	24
Total indicated horsepower	937
Coal consumption per hour	2,380 pounds
Water consumption per hour	20,300 "
Coal consumption per horsepower-hour	2.55 "
Water consumption per unit	21.7 "
Evaporation of water per pound of coal	8.53 "

Speeds.	Revolutions.	I. H. P.	Admiralty Coefficient.
8	18.0	210	254
9	20.25	276	275
10	22.6	380	274
11	25.0	536	264
12	27.5	725	248
13	30.0	937	244
13.2	30.4	990	242



PROGRESSIVE CURVES OF PERFORMANCE OF THE DANNEBROG.

The curves show graphically the result of these progressive trials, the performance, as indicated by the admiralty coefficient, being very good. The fuel endurance, based on the 4-hour run, appears to be about 1,300 nautical miles at a speed of 13.04 knots. The most economical speed is from 9 to 9½ knots. The index, according to which the power varies, as compared with the speed, is only 2.32 from 8 to 9 knots, becoming 3.47 between 11 and 12 knots, and 3.2 between 12 and 13 knots.

Notice.—On page 127 of our March number there was published by inadvertence an article which now appears to have been copyrighted and published by *Engineering* (London), Oct. 4, 1907. This was furnished us as an original article covering the Crocco-Ricaldoni hydroplane, and was accepted in good faith. We regret that its publication has put us in a bad light, and extend herewith our acknowledgments to *Engineering*.

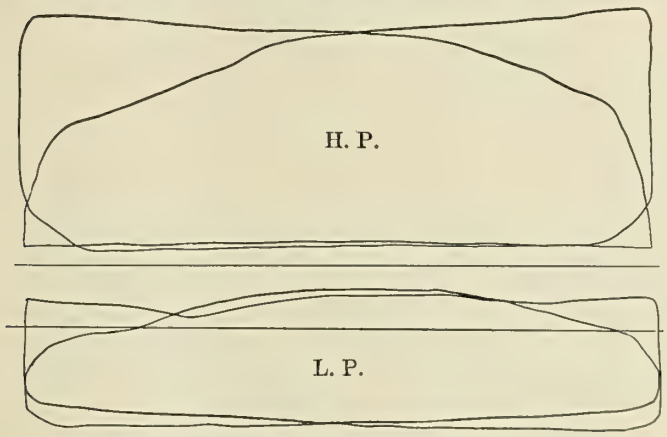
Trials of Lightship Number 88.

In September and October of 1907 we published an extensive description of five light vessels built for the United States Government by the Harlan & Hollingsworth Corporation, Wilmington, Del. The lighthouse board has been good enough to furnish us with details of the trials of one of these five vessels.

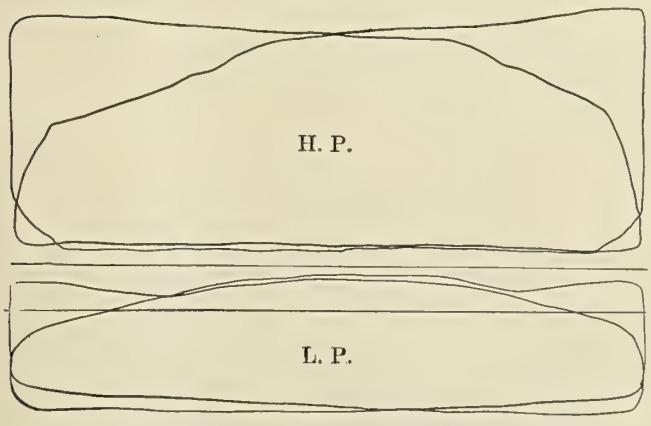
The ship has a length over all of 135 feet 9 inches, a length on the waterline of 112 feet 11 inches, a molded beam of 27 feet and a mean draft on trial of 12 feet 1 inch. The trial took place in the Delaware River Nov. 22, 1907, and the displacement (fresh water) was 576 tons. The block coefficient was 0.572, and the wetted surface 4,749 square feet.

There is one compound engine, driving a solid four-bladed propeller. The engine has cylinders 16 and 31 inches in diameter, with a stroke of 24 inches, cutting off in the high-pressure at 66 percent. The diameter of piston rod is 3½ inches. The cooling area of the surface condenser is 1,160 square feet. The propeller has a diameter of 7 feet 9 inches, a pitch of 10 feet and a pitch ratio of 1.29. The developed area is 2,328 square inches, and the projected area 1,840 square inches. The ratio of projected to disk area is 0.271.

Steam is furnished by two boilers exhausting into a single stack 4 feet in diameter and 45 feet high above the grate.



SAMPLE INDICATOR CARDS FROM STANDARDIZATION RUNS.

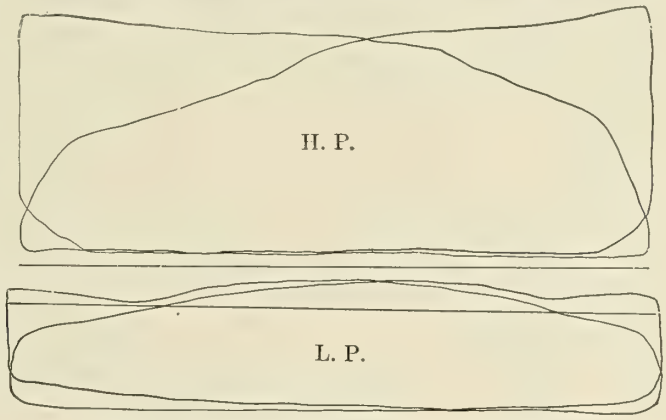


CARDS FROM 6-HOUR FULL POWER TRIAL.

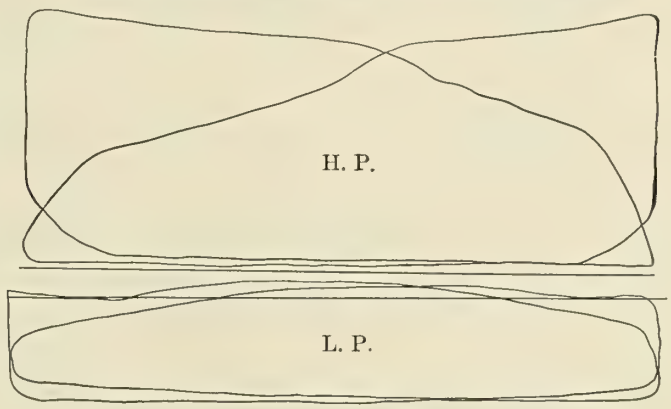
These boilers are of the gunboat type, working under natural draft, and have a diameter of 9 feet 3 inches and a length of 16 feet 3⅜ inches. The working pressure is 100 pounds per square inch. The total heating surface is 2,874 square feet, with a grate area of 73.2 square feet, giving a ratio of 39.26 to 1.

Two sets of runs were made, one set being over the measured mile (5,280 feet), while the other was a 6-hour continuous trial at full power. The measured mile trials consisted of three runs in each direction, in order to determine the revolutions required for a speed of 10 knots. The mean of all the runs showed a speed of 9.98 knots with 125.7 revolutions per minute, and a slip of 19.2 percent. During the 6-hour trial the maximum horsepower observed was 394, the mean having been 320 horsepower, 119.9 revolutions per minute and a vacuum of 26.66 inches. The mean steam pressure in the boilers was 98.6 pounds per square inch.

Four sets of cards are shown, one set being taken during



LINKED-UP CARDS—HIGH-PRESSURE CUT OFF, FIVE-EIGHTHS.



LINKED-UP CARDS—HIGH-PRESSURE CUT OFF, ONE-HALF.

Standardization Run.	High-Pressure, Top.		Bottom.		Low-Pressure, Top.		Bottom.
R. P. M.	....	....	....	126	....	....	....
Vacuum	....	....	....	26.5	....	....	....
I. H. P.	....	....	....	360	....	....	....
I. H. P.	....	206	....	....	....	154	....
Steam pressure	....	97	....	....	....	*6.25	....
Mean effective pressure	71.24	....	66.28	....	13.29	....	13.68
Mean reduced pressure	....	....	....	31.42	....	....	....

Six-Hour Trial.	High-Pressure, Top.		Bottom.		Low-Pressure, Top.		Bottom.
R. P. M.	....	....	....	126.5	....	....	....
Vacuum	....	....	....	26.7	....	....	....
I. H. P.	....	....	....	359	....	....	....
I. H. P.	....	204	....	....	....	155	....
Steam pressure	....	96	....	....	....	*6.25	....
Mean effective pressure	69.42	....	66.11	....	13.67	....	13.36
Mean reduced pressure	....	....	....	31.21	....	....	....
Linked-Up ⅝.							
R. P. M.	....	....	....	122.5	....	....	....
Vacuum	....	....	....	26.8	....	....	....
I. H. P.	....	....	....	329	....	....	....
I. H. P.	....	193	....	....	....	136	....
Steam pressure	....	95	....	....	....	*4	....
Mean effective pressure	68.12	....	64.3	....	12.62	....	11.89
Mean reduced pressure	....	....	....	29.55	....	....	....
Linked-Up ½.							
R. P. M.	....	....	....	118	....	....	....
Vacuum	....	....	....	26.8	....	....	....
I. H. P.	....	....	....	298	....	....	....
I. H. P.	....	175	....	....	....	123	....
Steam pressure	....	97	....	....	....	*2	....
Mean effective pressure	62.28	....	59.5	....	11.81	....	11.12
Mean reduced pressure	....	....	....	27.77	....	....	....

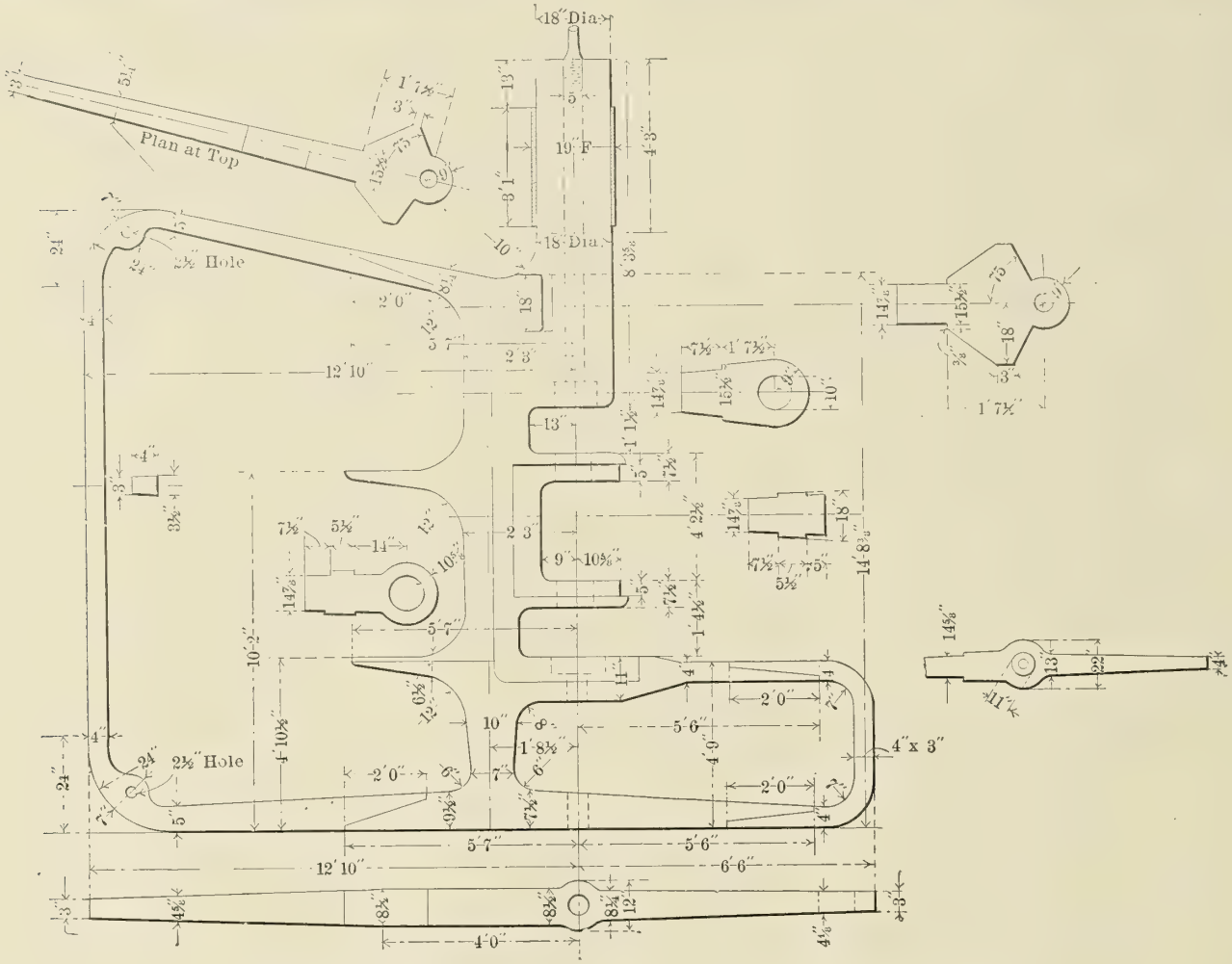
* Receiver pressure.

the standardization run, one during the 6-hour trial, and two sets of linked-up cards on cut-offs of ⅝ and ½, respectively. The results corresponding with these various cards are shown in the table.

Observations of the auxiliary machinery showed a mean revolution per minute for the circulating pump of 196; for the air pump, 33; for the feed pump, 18.6. The temperature on deck was 55 degrees F., with the following observed temperatures below: Engine room, 80; injection water, 41.9; outboard discharge, 86.6; hot well, 102.6; feed heater, 158 degrees. The indicator springs used were in all cases 60 pounds per inch for high pressure and 20 pounds for low pressure.

the dimensions are shown on the drawings, but some features not so shown may be given here.

The rudder frame of the battleship *Ohio* is made of wrought iron, and weighs 29,860 pounds. The total weight of the rudder, including filling, is 43,448 pounds. The different items outside of the frame include the top plate, 1,370 pounds; center plate, 2,015 pounds, and bottom plate, 2,805 pounds. The pintles, with composition sleeves, account for 1,444 pounds; the Oregon pine filling for 3,859 pounds; the angle and plate stiffeners inside the rudder for 718 and 596 pounds, respectively; while smaller items make up the total. This rudder has a maximum height of 15 feet 11⅜ inches and a



DETAILS OF THE WROUGHT-IRON RUDDER FRAME OF THE UNITED STATES BATTLESHIP OHIO.

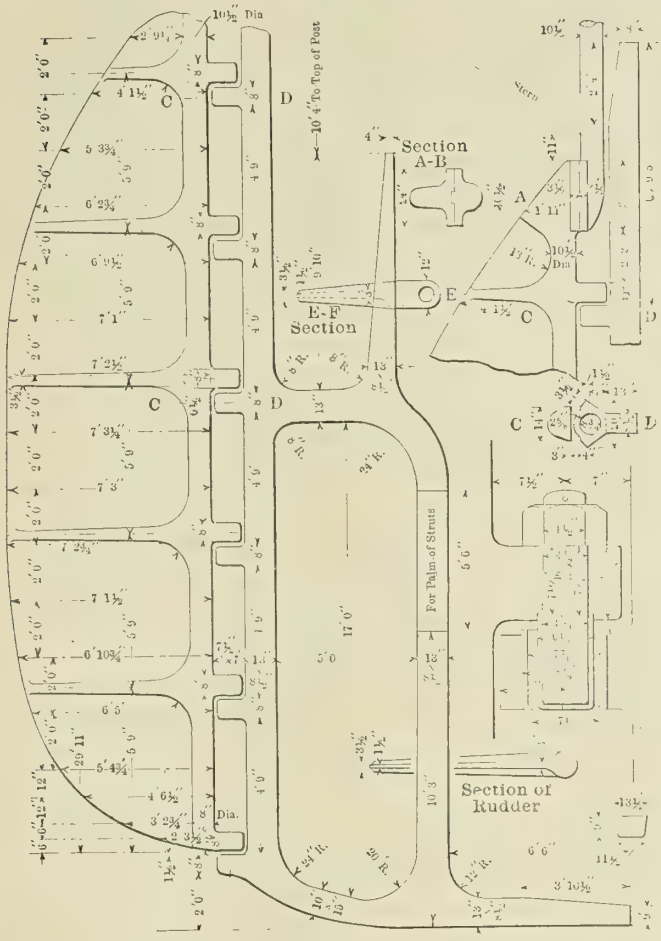
A FEW CONSTRUCTIVE DETAILS.

Through the courtesy of a correspondent, we are enabled to present a number of details of rudders, rudder frames, spectacle frames and propeller struts, steering-gear details, stern posts and counters, ram stems, bilge keels and hawse pipes. These cover Pacific coast practice in both warships and mercantile vessels, and are thoroughly up to date, most of the designs having been made within the last seven or eight years.

RUDDERS AND FRAMES.

Four examples are given, they being, respectively, from the American-Hawaiian Steamship Company's steamers *Mexican* and *Columbian*, the United States cruiser *Milwaukee*, the armored cruiser *California* and the first-class battleship *Ohio*. The warship rudders are all balanced and are of similar form. Reference to the drawings will show how radically the steamship rudder differs from the others. In general, total fore and aft length of 19 feet 4 inches, of which 12 feet 10 inches covers the portion aft of the axis. The rudder stock has a diameter of 18 inches, and is fitted with a brass sleeve 19 inches in external diameter. The total height of the rudder, including stock, is 19 feet 11⅛ inches.

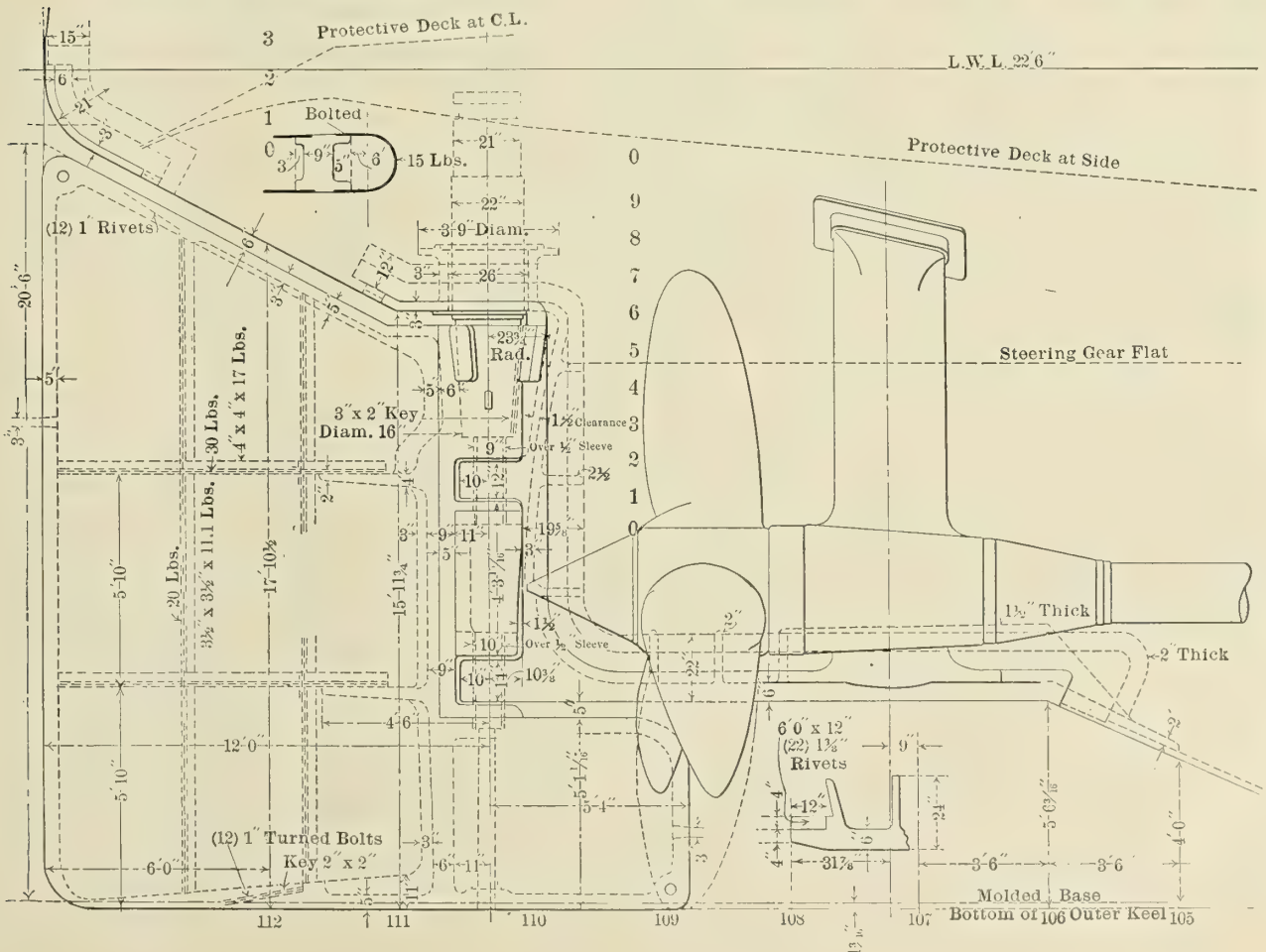
The rudder of the *Mexican* is of cast steel, with a rudder stock of wrought steel, the latter weighing 6,166 pounds. The stern frame is of wrought iron, with a weight of 33,900 pounds. The rudder stock has a diameter of 10½ inches, and is fastened to the rudder by means of a palm, 24 inches wide and 30 inches deep. Connection is made by means of eight turned bolts, 2¾ inches in diameter and located on two vertical lines 17½ inches apart. The backbone of the rudder has a diameter at the head of 10½ inches and at the foot of 8 inches. The rudder pintles have a net diameter of 5¼ inches and a diameter over bushing of 6⅛ inches. The total height of this rudder to top of palm is 32 feet 5 inches; the length of the stock is 18 feet 3 inches.



STERN FRAME AND RUDDER OF STEAMSHIP MEXICAN.

The rudder of the *Milwaukee* consists of a stock of forged steel weighing 10,179 pounds; a rudder frame in two pieces, of which the forward part weighs 26,640 pounds, and the after part, 2,450 pounds; stiffening and side plates and angles aggregating 9,040 pounds; filling of Oregon pine and a composition of one-half tar and one-half pitch, amounting to 6,167 pounds, and other items making up a total of 56,591 pounds. The stern post weighs 39,200 pounds, and is of cast steel. The cast-steel counter-casting accounts for 1,900 pounds, and the watertight gland for 1,226 pounds. The maximum height of the rudder is 20 feet, the total length being 17 feet 4 inches, 5 feet 4 inches of which is forward of the axis. The rudder stock has a diameter of 21 inches, and is fitted with a sleeve of an outside diameter of 22 inches. The inner diameter of the watertight gland is 26 inches. The outside plates are of 15-pound steel. The total area of the rudder is 235.74 square feet, of which 208.96 square feet, or 88.7 percent, is aft of the axis. The center of gravity is 5.29 feet aft of the axis, and 8.08 feet above the bottom.

The rudder of the *California* differs from those of the other two warships mentioned in that the top line is horizontal, instead of following the shape of the bottom of the ship aft of the rudder axis. This rudder has an area of 249 square feet and a total weight of 53,022 pounds. The stern post weighs 26,580 pounds, being of cast steel, while the counter-casting weighs 9,000 pounds. The total weight of the rudder includes two frame castings, of which the forward one weighs 24,553 pounds and the after one 1,875 pounds. The stock weighs 8,037 pounds; the side plating, 7,005 pounds; the plate and angle stiffeners, 2,008 pounds; the filling of Oregon pine, with a composition consisting half of tar and half of pitch, weighs 6,630 pounds; smaller items make up the total. Of the total area of this rudder, 209.82 square feet, or 84.3 percent, is aft of the axis. The center of gravity of the rudder is 5.14 feet aft of the axis, and 7.04 feet above the lower edge. The total



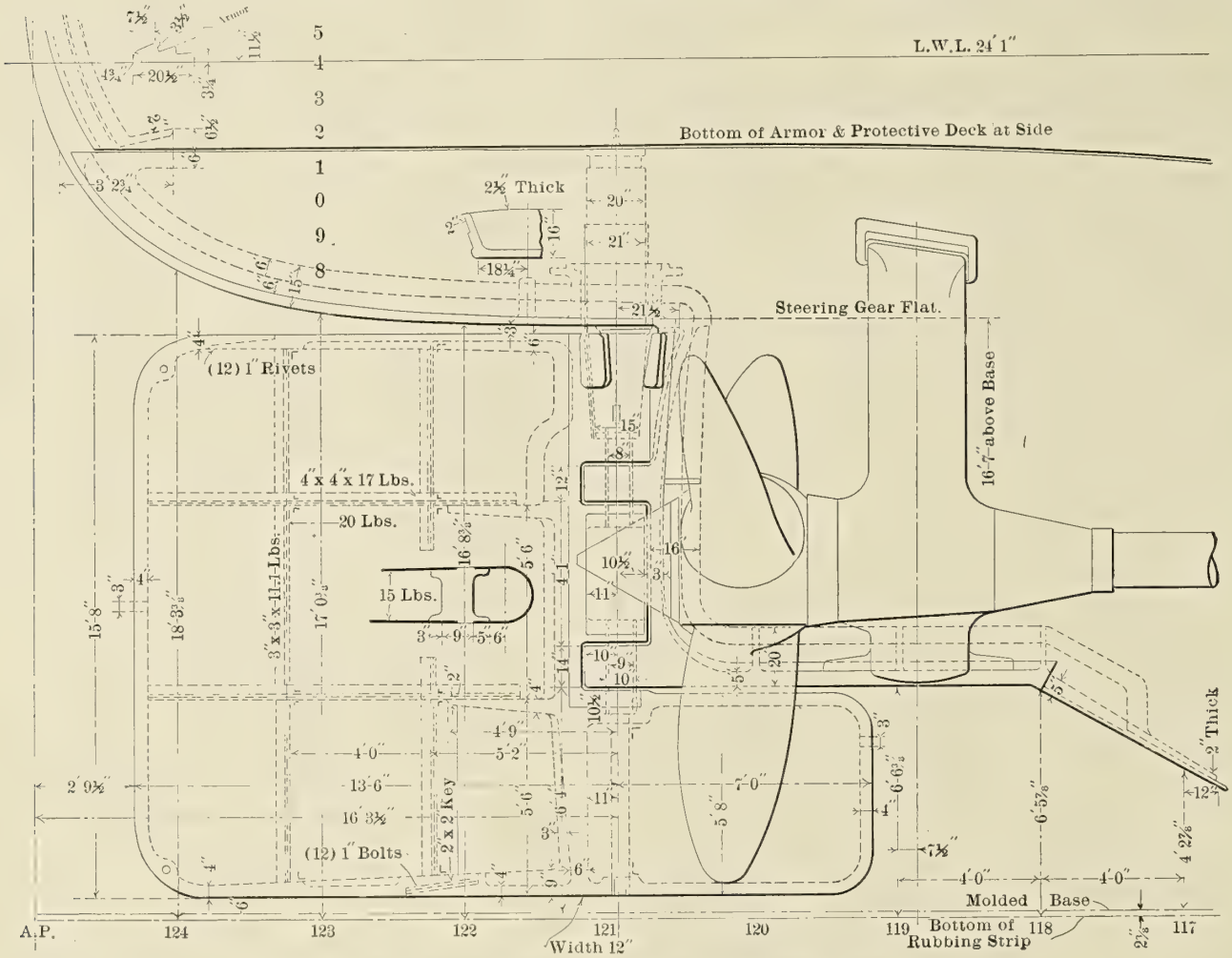
STERN POST, RUDDER AND COUNTER CASTING OF THE SEMI-ARMORED CRUISER MILWAUKEE.

height of the rudder is 15 feet 8 inches, while the bottom is located 6 inches above the molded base line of the ship. The extreme length of the rudder is 20 feet 6 inches, of which 7 feet is forward of the axis. The after side of the rudder, which is vertical, is 2 feet 9½ inches forward of the after end of the waterline of the ship, whereas in the case of the *Milwaukee*, the rear edge of the rudder is in line with the after end of the waterline. The side plating of the *California's* rudder is 15 pounds per square foot.

(To be Continued.)

	Meters.	Feet.
Length between perpendiculars	104.32	342.
Greatest molded breadth	14.17	46.5
Depth to main deck	8.42	27.6
Height of turret deck	1.9	6.2
Breadth of turret deck	7.8	25.6
Area of immersed midship section	94.38	1,017,
Area of loadwater plane	1,307.8	14,080.

The bunkers hold 500 tons, and the ship can be coaled from either the turret deck or the shelter deck. On the latter is a



THE STERN POST, RUDDER AND COUNTER CASTING OF THE ARMORED CRUISER CALIFORNIA.

The German Ore Steamer Narvik.

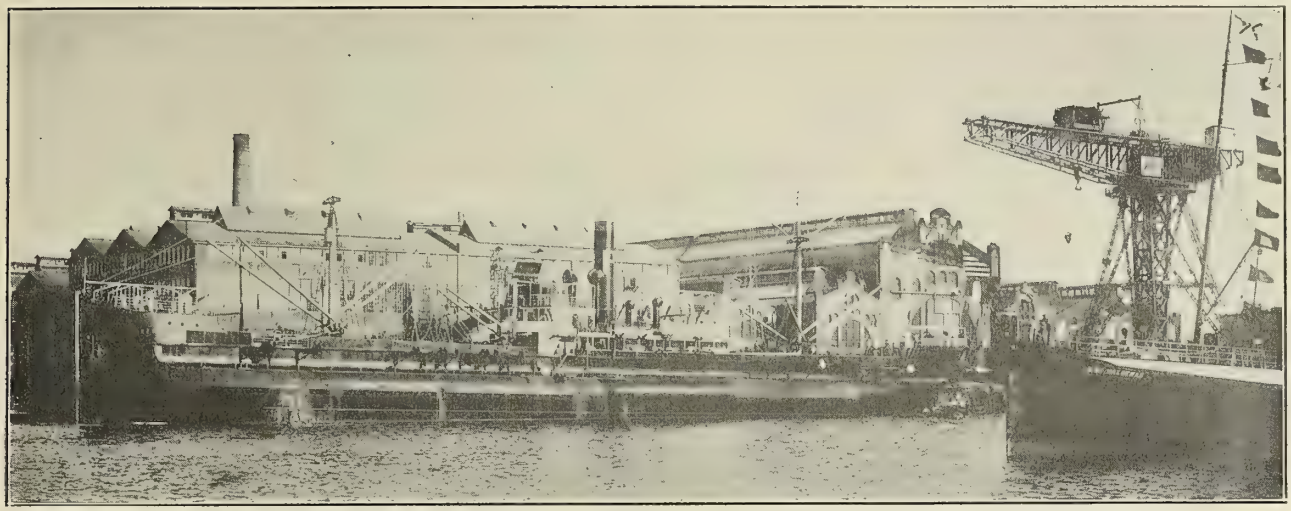
BY E. OMMELANGE.

This ship is the first turret-deck steamer built in Germany on the principle so largely developed by William Doxford & Sons, Sunderland. It has been in service since the end of 1905, and during this time has shown that the construction and design were well carried out. The keel of the *Narvik* was laid in August, 1904, at the Krupp Germania-Werft, Kiel; the ship was launched April 29, 1905, and made her first trial trip under ballast on Aug. 2, 1905. The contract speed of 11.5 knots was reached on the measured mile, in spite of heavy weather, with a mean of 1,750 horsepower.

The ship is a single-screw steamer, built according to the requirements of the German Lloyds to class 100 A L (E), and is built of steel. She has a capacity of about 6,000 tons of cargo, and, with full bunkers and complete outfit, has a draft of 6.86 meters (22 feet 6 inches). This corresponds with a displacement of 8,622 cubic meters, or 8,380 tons. The main dimensions are as follows:

hatch forward of the engine casing, in which a chute has been built, in order to fill the lower bunkers directly. From the turret deck the coal can be delivered into this chute through hinged doors. Besides this, coaling scuttles have been provided on the deck outside the turret proper. The second hold may be put in connection with the fire room by means of a vertical watertight sliding door, so that it can serve as a reserve bunker. The ship can carry a total of 2,300 tons of water ballast, of which 1,600 tons are in the double bottom. The net and gross register tonnages are respectively 3,575 and 2,299.

In designing the separate portions of the structure, the ship follows the normal requirements of the German Lloyds, but in some particulars deviates from them. These are especially in the greater height of the double bottom, and in the provision of the turret deck, which calls for particular consideration. The thickness of the inner bottom was regulated with due regard to the great weight of a carload of ore, which it was required could be dumped in bulk into the hold. On that



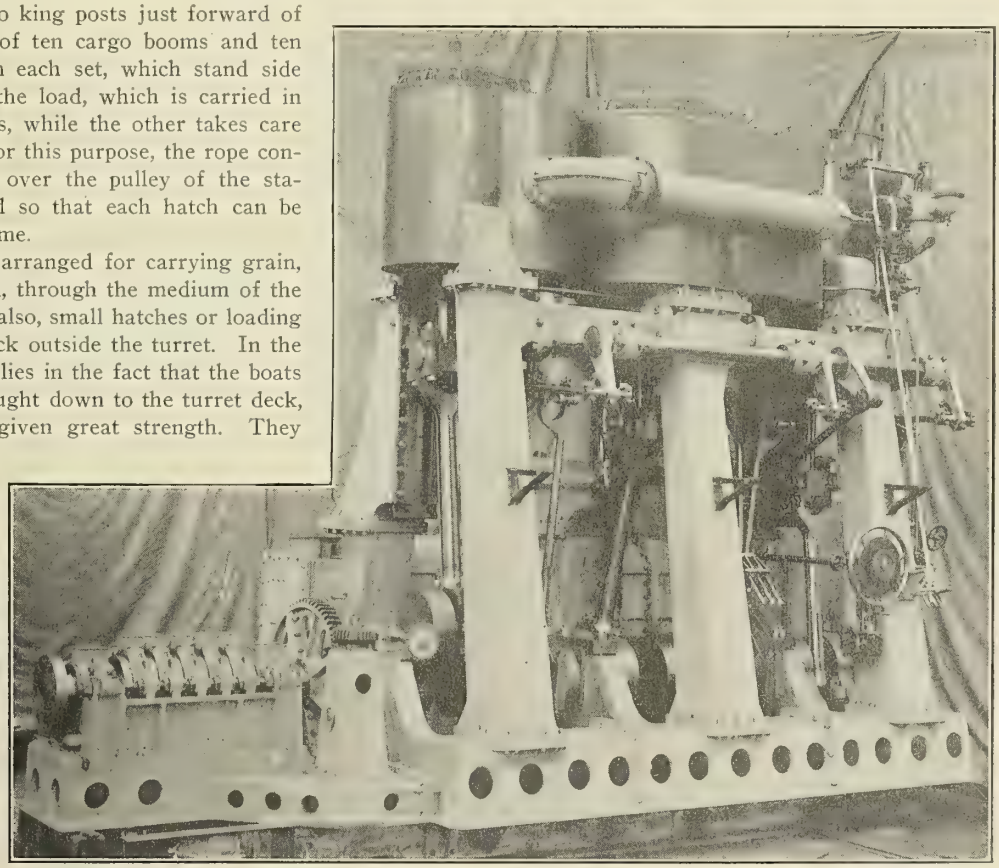
THE TURRET STEAMER NARVIK ALONGSIDE PIER, IN COURSE OF LOADING BULK CARGO.

account the double bottom is divided into square compartments on the longitudinal system. Under the hatches the double bottom, which is covered with pitch-pine planks, 65 millimeters (2½ inches) thick, is strengthened by a doubling of fir. In order not to limit too much the size of hold, the stanchions under the hold beams are placed only at the ends of the hatches, and are made correspondingly stronger. The outer skin is joggled, and, in order to save weight, the angle bars are replaced as much as possible by flanges.

In the design of the ship, the principle object in view was to give the greatest possible celerity to the operations of loading and unloading. For each of the four holds there are two cargo booms and two winches. In addition to this, the largest hold has, for the purpose of loading and unloading as quickly as the others, an additional two cargo booms and two winches, the former being mounted on two king posts just forward of the bridge. This makes a total of ten cargo booms and ten winches. Of the two winches in each set, which stand side by side, one is used for raising the load, which is carried in buckets supported by three chains, while the other takes care of the swinging of the booms. For this purpose, the rope controlling this swinging is carried over the pulley of the stationary boom; for it is arranged so that each hatch can be emptied from only one side at a time.

In order that the ship may be arranged for carrying grain, the turret tanks may also be used, through the medium of the large hatches. For this purpose, also, small hatches or loading chutes have been fitted on the deck outside the turret. In the outfit of boats, particular interest lies in the fact that the boats above this outer deck may be brought down to the turret deck, and the davits here have been given great strength. They naturally may be swung out much farther from the ship's side than would be the case with davits above.

The officers' quarters are separated from the engine-room crew. The first are alongside the captain's quarters forward, in two deckhouses, one above the other, which contain also the saloon, spare room, toilet and bath. The crew and stewards, cook, etc., are also in two structures, one over the other, which are further aft, and in the neighborhood of the engine room. The crew's mess room is in the same structure. The commander's bridge, which reaches over the full breadth of the ship, is protected by a solid substructure against a heavy sea. This serves to cover storerooms, signal lights and companionways. The ship may be steered from either the upper or the lower bridge. A reserve hand-steering device is located on the



THE TRIPLE EXPANSION ENGINE OF THE TURRET STEAMER NARVIK.

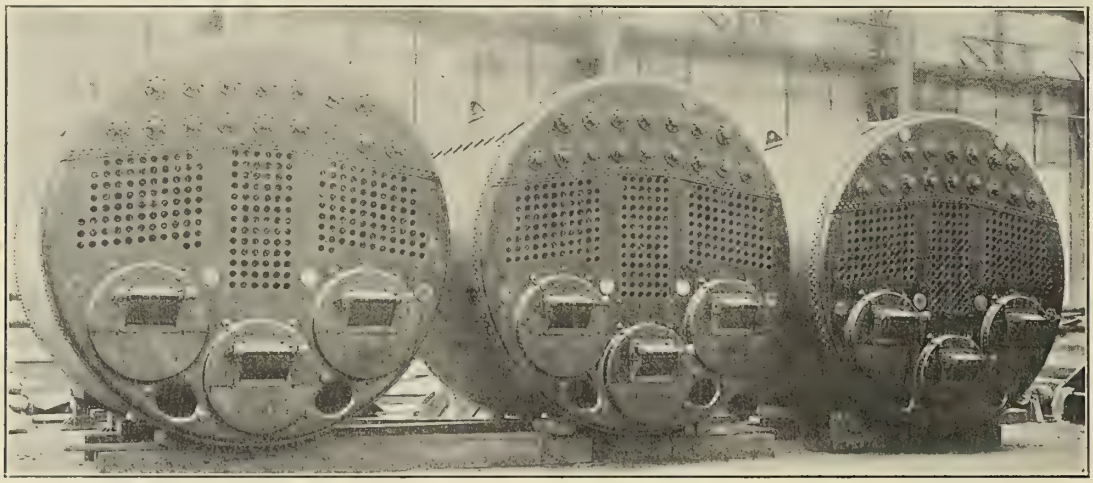
poop. The steam-steering outfit is in the turret deck on a platform opening above the engine-room shaft.

The ship is driven by a triple-expansion engine with three cylinders, the diameters of which are respectively 600, 970 and 1,600 millimeters (23⅝, 38¼ and 63 inches), with a common stroke of 1,150 millimeters (45¼ inches). With a steam pressure of 13 atmospheres (191 pounds gage per square inch), the revolutions are seventy-eight per minute. The three cylindrical return-tube boilers have altogether a heating surface of 550 square meters (5,915 square feet), and a grate surface of 16.5 square meters (177.5 square feet). The ratio is thus 33.3 to 1. Each boiler is single ended and has three corrugated furnaces. The steam used in the auxiliary machinery is exhausted into the main surface condenser.

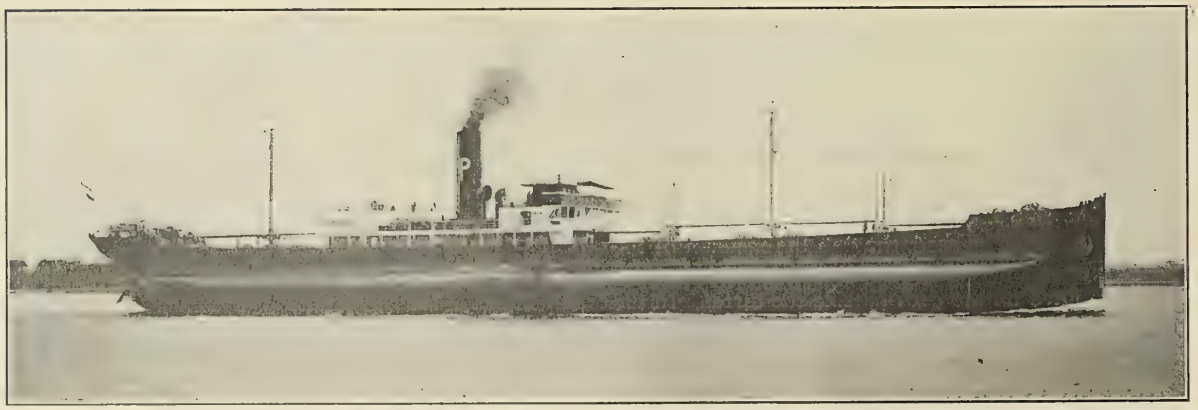
	Meters.	Feet.
Length between perpendiculars	112.77	370.
Maximum width, molded	15.85	52
Side depth below main deck	9.09	29.8
Draft	7.32	24
Displacement with loaded bunkers and full equipment	11,110 tons	

The *Nordsee* is provided with a continuous double bottom 1.14 meters (45 inches) in height, and, in front of the boiler room, above this double bottom, with a deep tank, 3.65 meters (12 feet) in height. This arrangement was chosen specially with a view to the use of the steamer for the transport of ores, as the centers of gravity of the load, as well as of the ballast, are thus raised, decreasing the excessive initial stability, and thus enabling the ship to perform a more uniform and steady motion in the case of a rough sea. The deep tank will furthermore prove valuable in the case of sailing with ballast, enabling the propeller to be submerged entirely. The bilge keels, 60 meters (197 feet) in length and 30 centimeters (12 inches) in breadth, likewise contribute to improving the behavior of the ship in the case of a rough sea.

The double bottom and deep tank, inclusive of the fore and rear peaks, may contain an aggregate of 3,050 tons of water ballast, which, by the aid of the powerful pumping plant of the steamer, can be emptied within five hours. The vessel is divided into six compartments by five watertight transversal bulkheads. The fore and rear peaks, as above mentioned, are



THREE SINGLE-ENDED BOILERS OF THE GERMAN ORE-CARRYING STEAMER NARVIK.



THE GERMAN TURRET STEAMER NORDSEE STEAMING IN BALLAST, AT LIGHT LOAD LINE.

A LARGE ORE TRANSPORTING STEAMER.

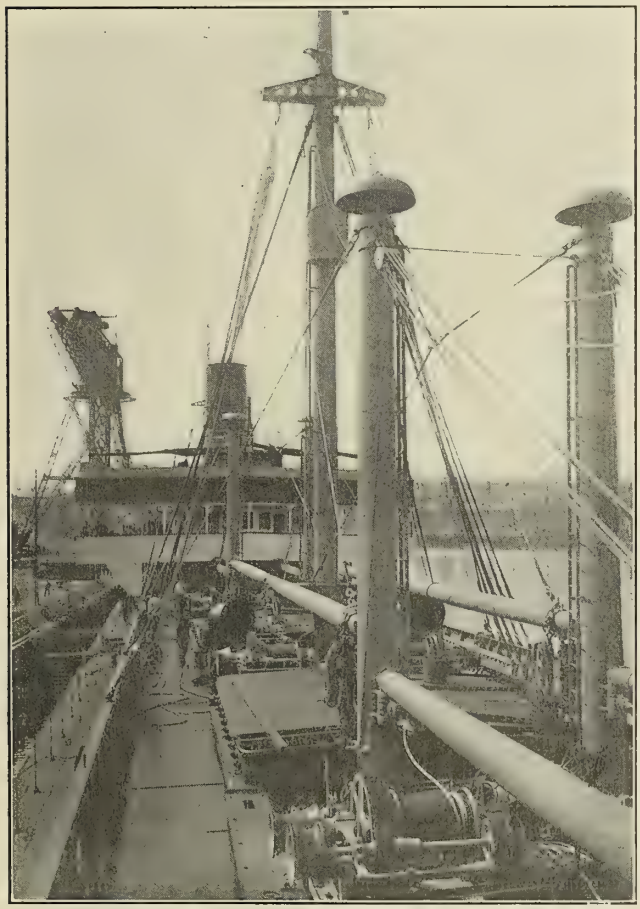
BY DR. ALFRED GRADENWITZ.

The ore transporting steamer *Nordsee,* which was recently built by the Krupp Germania-Werft, Kiel, is the largest turret-deck steamer of the German mercantile fleet in the Baltic. In fact, while being mainly designed as sister ship to the turret-deck steamer *Narvik** (constructed at the same yards) the *Nordsee,* which was built of Siemens-Martin steel as a single-screw steamer for the highest class of German Lloyds under the latter's special survey, surpasses the capacity of the former ship by about 1,750 tons. The following are the main data of the vessel:

* See page 200.

used with the double bottom and deep tank for the storing of water ballast. The second, fourth and fifth compartments are used as hold, while the third contains the propelling machinery. The engine and boiler rooms are separated from one another by a bulkhead reaching up to the turret deck. In front of the boiler room has been arranged a transverse bunker of about 600 tons capacity.

The engine and boiler plants have likewise been constructed at the workshops of the Germania shipyards. The main engine is triple-expansion, working on three cranks, with cylinders 600, 980 and 1,620 millimeters (23⅝, 38⅝ and 63¾ inches) in diameter, and 1,150 millimeters (45¼ inches) in stroke, and is provided with all improvements for insuring economical operation. Three cylindrical tubular boilers, with



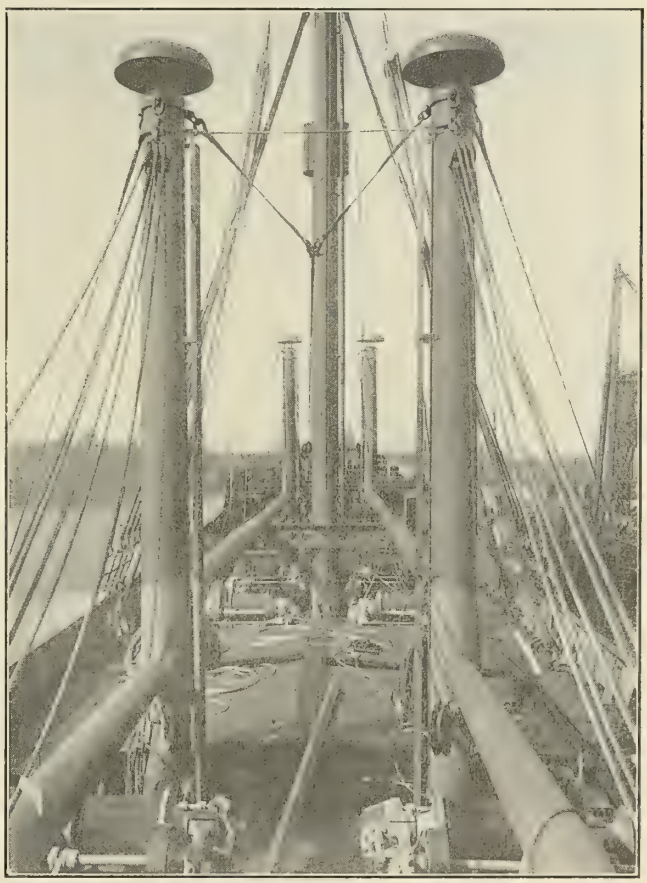
VIEW ON NORDSEE, LOOKING AFT FROM FORECASTLE.

return flues, are used for generating the steam. These have a total heating surface of 480 square meters (5,170 square feet) as measured on the water side, and 12 square meters (129 square feet) grate surface; the ratio being 40 to 1. They are designed for a steam pressure of thirteen atmospheres (191 pounds per square inch), and provided with artificial draft on the Howden system.

In order to allow of a rational utilization of the ship, special attention has been bestowed on making the loading and unloading plants as perfect as possible. The steamer accordingly has six hatches, each of which is 6 meters (19 feet 8 inches) in length by 5.5 meters (18 feet) in width, and two of these are used for each hold compartment. Two steel masts, 33 meters (108 feet) in height, are arranged, one forward and one aft; each of these carries four wooden outriggers (cargo booms). In addition, there are provided forward, four loading poles (king posts) with one outrigger each. These twelve outriggers are operated by twelve steam winches, the

BOW VIEW OF THE NORDSEE.

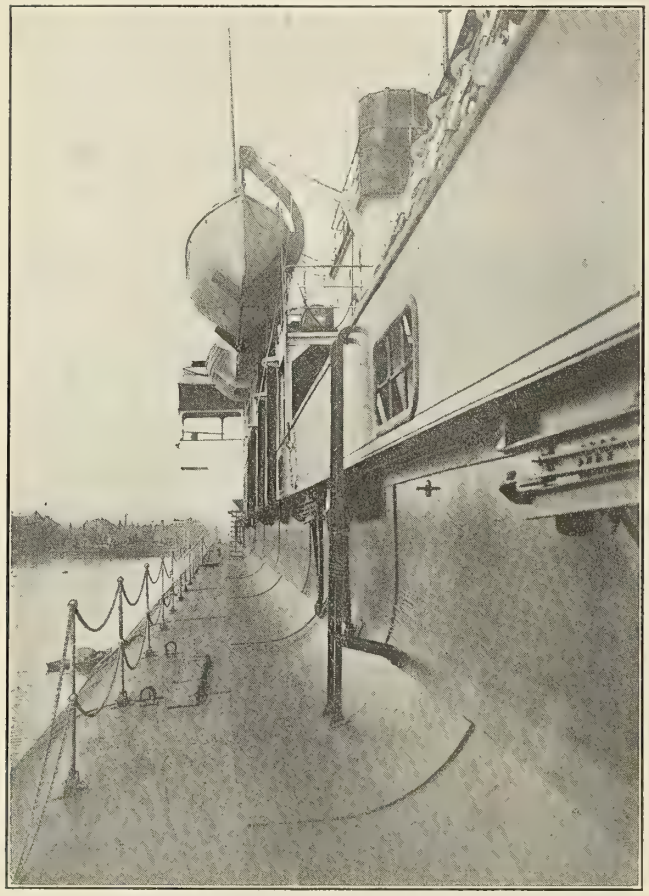
steam supply for which has been so designed as to allow all of them to work simultaneously. All the outriggers are balanced, the pivot of the outrigger and the point of attachment of the load being situated in the same vertical plane. Means



VIEW ON NORDSEE, LOOKING FORWARD FROM BRIDGE.

have furthermore been provided for allowing the pendants of the outriggers to be automatically slewn, by displacing their points of suspension.

The unloading operation is further accelerated by the loading platforms arranged for hinging, one of which has been installed at each side of each hatch, giving an aggregate of



VIEW ALONG THE OUTER LOWER DECK OF THE NORDSEE.

twelve. They are arranged at such a distance as to allow the wooden hatch covers to be used as well for these platforms. The latter are used for receiving the loading buckets filled with ore, and, on the other hand, for attaching shoots, through which the ore is conveyed directly into the lighter ships placed alongside. The substantial hauling winch, intended for maneuvring the vessel and lighters, in no small degree contributes to further improving the efficiency of the loading and unloading plants.

By the aid of these means, the whole of the load (7,600 tons) can be discharged within 36 hours at most, while, according to the experience gained in connection with the sister ship *Narvik,* the time limit will be most likely reduced by some hours. The loading from railway trucks on the quay takes only about 10 hours. As a whole wagon load (carload) of ore is dumped at once from a considerable height into the hold, the double bottom has been protected by substantial double planking within the range of the loading hatches.

The accommodation provided for the staff and crew is exceedingly spacious, and of remarkably tasteful design. The whole of the fittings, including the elegantly designed furniture of the drawing room, and the specially well upholstered captain's rooms, have likewise been constructed at the shipyard.

The machinery and deck staffs are strictly separated from one another, each of the two categories having a mess designed for twelve men, which, like the remaining rooms of the ship, have been provided with electric lighting. The cabins are arranged most conveniently, the captain being enabled from his berth to watch anything that may occur on the navigating bridge, while the machinists' quarters give direct access to the engine room. The bridge, extending throughout the breadth of the ship, is protected against breakers by an entirely inclosed sub-structure, containing the stairs, as well as the rooms for storing the signaling lanterns.

While being mainly intended for the transport of ore between the Norwegian harbor of Narvik and Rotterdam, the installations of the ship will enable her to be used as well for the transport of other goods in bulk, such as coal, corn, etc.

In connection with her first journey, made a short time ago, the steamer far exceeded any expectations warranted by the excellent results of the trial runs. In fact, the contract called for a speed, with about 7,600 tons load, inclusive of the bunker coal, of 10 knots. Instead of this, with a surplus load of 356 tons (a total load of 7,956 tons) a speed of 11.46 knots was reached downstream, and 10.21 knots upstream, giving an average of 10.83 knots. This surplus of capacity and speed constitutes a remarkably satisfactory result, considering the displacement of the ship, and especially her extremely low coal consumption.

A New Trunk Deck Cargo Steamer.

BY BENJAMIN TAYLOR.

We present particulars of the steel screw cargo steamer *Romanby,* built by Ropner & Sons, Ltd., Stockton-on-Tees, for British owners. She was built to the highest class of British Corporation, and is fitted with the patent improved trunk deck of the builders with clear holds and deep frames. The dimensions of the vessel are:

Length	365 feet
Breadth	50 feet
Depth	23 feet

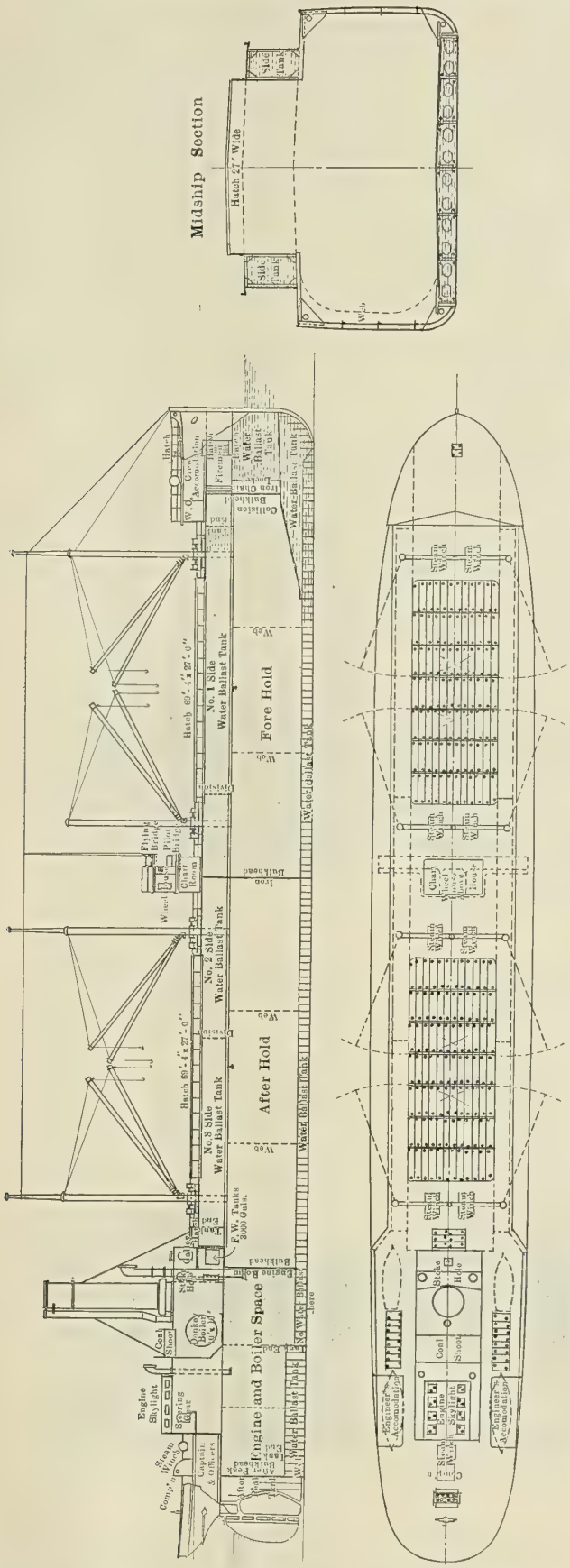
The saloon house, with accommodation for captain and officers and a house for engineers, is fitted up on trunk deck, with the crew in topgallant forecastle and apprentices aft.

The vessel has double bottom for water ballast on the cellular principle, also in the fore and after peaks. The deadweight-carrying capacity is about 6,100 tons on summer freeboard. She is fully equipped with an up-to-date outfit, including a quick-warping windlass, stockless anchors, steam steering gear amidships, with powerful screw gear aft. The appliances for loading and discharging expeditiously are very complete, and include extra derrick posts and double derricks and nine steam winches, steam being supplied by a horizontal multitubular donkey boiler, 10 feet diameter and 10 feet long.

The engine is of the triple expansion type, with cylinders 25, 41 and 67 inches in diameter by 45-inch stroke, and of 1,500 indicated horsepower. Steam is supplied by two large single-ended main boilers, 16 feet in diameter by 10 feet 6 inches long, at a working pressure of 180 pounds per square inch. These boilers are fitted with Brown's improved patent furnaces.

The *Romanby* will carry 6,200 tons on the low draft of 21 feet 4 inches. She has very clear holds. Her frames are bulb angles with no hold beams, wide stringers, or quarter pillars; a few center line pillars are fitted, to carry shifting boards. This type of vessel is very suitable for the grain trade, as the trunk forms a permanent feeder, and there is consequently no danger from grain cargo shifting, and bagging is reduced to a minimum. This steamer will also carry timber cargoes very successfully, as the space within the trunk secures full freightage, and the trunk forms a key to which the deck cargo is secured, to prevent any possibility of its being carried away.

A similar steamer, for the coal-carrying trade, is fitted with large deck water ballast tanks situated within the trunk, which



PROFILE, DECK PLAN AND MIDSHIP SECTION OF A VESSEL OF THE TYPE OF THE ROMANBY, BUILT BY ROPNER & SONS, STOCKTON-ON-TEES.

makes a very steady ship when in light trim in rough weather. This coal steamer has two holds, or, if considered necessary, only one hold, with two long hatches, from 70 to 100 feet in length, and from 27 to 32 feet in breadth.

This type of patent trunk steamer is claimed to be the ideal cargo carrier, because the ships are self trimming, have clear holds and no obstructions, involve the minimum of coal-burning charges, have large cubical capacity with either single or double decks, take a very high percentage of cargo per net register ton, carry water ballast in trunk tanks well in from the ship's side and secure from external damage, permit of no damage to perishable cargoes from condensation, have continuous hold and wide hatchways, have very light draft for large deadweight, are very "sea-kindly" when in ballast trim, and are the easiest vessels afloat to load and discharge.

We give sections of a steamer of the *Romanby* type, specially adapted for coal and ore carrying.

The Cargo Steamer Echunga.

The *Echunga* is the largest of the cantilever framed top-side tank steamers, with complete shelter deck for horses or cattle, yet built by Sir Raylton Dixon & Company, Ltd., Middlesbrough, and has been designed and constructed to fulfil the very special requirements of the extensive coal, ore and cattle trade carried on by her owners, the Adelaide Steamship Company, Ltd., of Adelaide, South Australia. She is considered by experts to be one of the most complete and up-to-date cargo boats afloat.

Her leading dimensions are 405 feet in length, 56 feet beam, and 26 feet 8 inches molded depth, and she will carry about 8,400 tons on her assigned loadline, and has capacity for over 11,000 tons measurement cargo.

Her leading features place this vessel among the most effectively equipped cargo boats. In the first place she will carry a dead weight of about three and three-quarter times her net register tonnage, the latter being 2,245, and the former 8,400 tons on 23 feet 9 inches draft. Her water-ballast tanks will contain 3,200 tons, of which 1,350 is placed in the top-side tanks, and the remainder in double bottom and peaks, and when the vessel is to sail in ballast trim, the propeller will be immersed, and she will consequently be in extra trim for speed results and good sea-going condition. Her five hatchways are of extraordinary size, all being 30 feet wide, and the longest 42 feet long. She is a perfect self-trimmer, and her holds are absolutely clear of any obstruction, such as beams, webs or pillars. She has unique facilities for loading and discharging her cargo, being fitted with no less than fourteen derricks and eight gaffs; and having twenty-five extra powerful steam winches, which will enable thirty-two gangs of coal heavers to discharge her 8,400 tons of coal in 48 hours.

The vessel has a complete shelter deck all fore and aft. A large steel deck house is fitted on shelter deck amidships for officers' berths and saloon, with captain's room and wheel house above, and flying bridge on top of latter. The accommodation for engineers is provided in a large steel house aft, while the crew are berthed in shelter deck aft, and cattlemen in forecastle. The facilities for loading and discharging the cargo consist of two heavy masts, two crane posts, and cargo span. There are six derricks and four heavy gaffs on each mast, the two center derricks being equal to a working load of 10 tons, while the four side derricks will lift 8 tons each. On each gaff are three special gins for whipping coal, and a heavy steel derrick capable of lifting 20 tons is fitted on the mainmast. To work all this gear there are, around each mast, six special powerful steam winches, with cylinders 8 by 12 inches, and also four very heavy and specially designed frictional winches, and two ordinary winches at each crane post, making a total of twenty-five steam winches, including a very heavy warping winch, having cylinders 10 by 16 inches. This winch is placed aft in deck house, and is fitted with heavy extended warping ends, and on the main shaft there are also steering chain bands, fitted so that the winch could act as steering gear if necessary.

The shelter deck and 'tween decks are especially arranged

for cattle, horses or troops, and a complete system of cattle watering arrangement is provided, both in 'tween and on shelter decks. Heavy stanchions are fitted around the shelter deck, at suitable distances apart, to which wood framing for the exposed cattle pens may be attached. The vessel is otherwise very complete in accommodation for officers, crew and cattlemen, and has a complete installation of electric light.

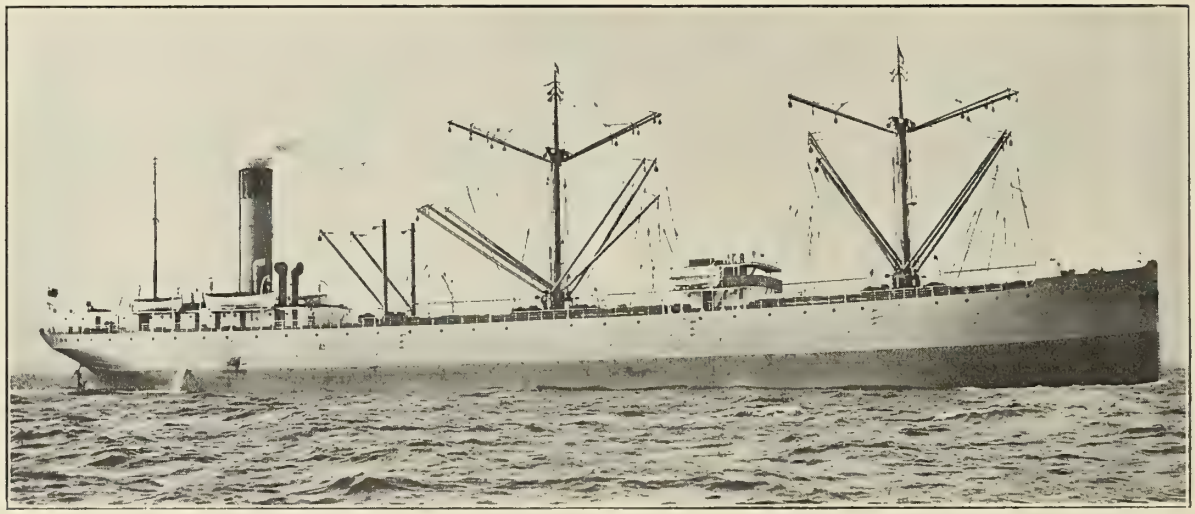
Triple expansion engines, which are placed right aft, have been fitted by Messrs. Richardsons, Westgarth & Company, Ltd., Middlesbrough, having cylinders 27½, 44 and 75 inches in diameter, by 48 inches stroke, supplied with steam by four large single-ended boilers, working at 180 pounds per square inch. The trial trips passed off most successfully, the vessel attaining a speed of 12¾ knots. The ship was built to the highest class in the British Corporation.

The Largest French Cargo Boat.

This steamer, *Meinam,* has been built by the Palmer's Shipbuilding Company for the account of the Messageries Maritimes. She is the largest purely cargo steamer of the French mercantile fleet, and has the following particulars:

Length over all	436 feet
Length between perpendiculars	411 feet
Extreme breadth	52 feet 5 inches
Depth molded	29 feet 9 inches
Gross register tonnage	5,420 tons
Deadweight tonnage	12,000 tons

The steamer is given the highest class in the British Corporation Register, and is built to Board of Trade regulations,



THE LARGE CARGO STEAMER ECHUNGA, BUILT BY SIR RAYLTON DIXON & COMPANY.

THE STEAMSHIP MEINAM, THE LARGEST CARGO STEAMER FLYING THE FRENCH FLAG.

Recent figures show that the British navy contains active vessels aggregating 1,590,096 tons, or 42.4 percent of the total accredited to the seven leading naval powers. The United States is second, with 517,775 tons, and 13.8 percent. France has 493,392 tons and 13.1 percent; Germany, 435,773 tons and 11.6 percent; Japan, 344,979 tons and 9.1 percent; Russia, 219,633 tons and 5.8 percent, and Italy, 156,312 tons and 4.2 percent. The four continental navies contain 1,305,110 tons, or 34.7 percent of the total.

on the deep frame and girder system. She is rigged as a two-masted schooner, is fitted with a long bridge house amidships, has a full poop and topgallant forecastle, and three steel decks worked from end to end. The ship has a cellular double bottom for water ballast, and is divided into nine watertight compartments.

The accommodations for the captain, officers and engineers are in the deckhouse on top of the bridge deck. All accommodations are commodiously and tastefully fitted out. The

main 'tween decks are 11 feet in height, which will give ample space for the carrying of horses, should this be necessary. There are large cargo hatches, and thirteen steam winches, with ample derrick accommodations, one being of 30 tons capacity, two of 10 tons, and twelve of 5 tons each, or fifteen derricks in all. They are provided for the rapid discharge of the cargo. The vessel is fully equipped with modern conveniences, including electric light.

The main engines are two in number, of the triple expansion, three-cylinder type, the cylinders being, respectively, 26, 45 and 76 inches in diameter; the stroke is 54 inches. The total indicated horsepower is 1,700. Steam is supplied to the main engines by three cylindrical boilers of the usual type, being 15 feet in diameter and 12 feet in length. They are fitted with the Howden's forced draft system.

This steamer, having been built to get the subsidy according to the April, 1906, regulations, and having a gross register of 5,420 tons, and having a trial speed over 10 knots, will, therefore, get as "compensation d'armement" during twelve years:

fr. 0.04 × 3,000 tons = fr. 120
0.03 × 2,420 tons = 72.60

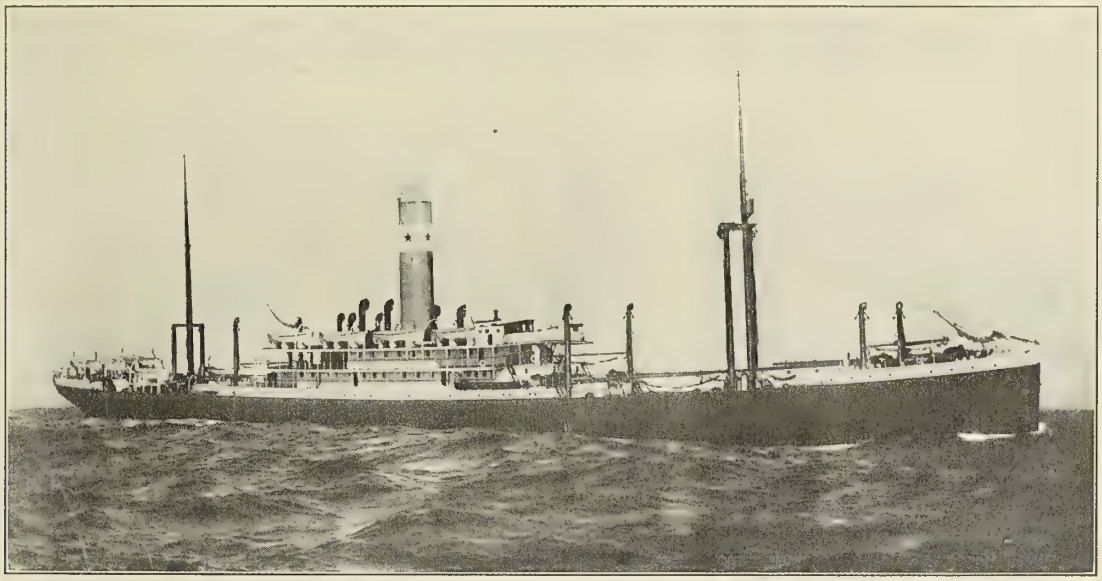
fr. 192.60 per day,

or fr. 69,336 per year. During the life of the subsidy, this will amount (assuming constant operation) to fr. 832,032 (£33,000 or $160,582).

This steamer is given the highest class in the French Veritas. She has been built on the deep frame and girder system, and is rigged as a two-masted schooner. There are three decks worked from stem to stern; above the main deck there is a top gallant forecastle, 55 feet in length, in which the crew, the petty officers and stewards are berthed.

Amidships there is a long bridge house, 182 feet in length, in which accommodations are provided for fifty-seven first class passengers in very roomy cabins; the staterooms being situated in the bridge, on the bridge in deck houses, and also in deck houses above that again. The dining saloon is at the front end of the bridge, and a drawing room and a smoking room are also provided, with several "en suite" rooms. The furnishing and outfit are severely plain, but they are especially suited for hot climates. Accommodations are also provided for steerage passengers, who will be located in the first 'tween deck. Aft there is a full poop, with accommodations for officers and a few passengers; the poop has a total length of 33 feet 6 inches.

The ship is divided into eleven watertight compartments, and a complete cellular double bottom extends from end to end. The total capacity of water in this double bottom is 1,322 tons; fore and aft in peaks 210 tons, and in special holds amidships 1,982 tons of water might be shipped; the total water carried on ballast trim therefore is 3,514 tons, which allows good seaworthiness to the ship for running long distances on ballast.



THE STEAMSHIP MALTE AT SEA, FULLY LOADED WITH 9,000 TONS OF COAL.

A Large French Steamer.

BY J. G. PELTER.

The steamship *Malte*, built to the order of La Compagnie des Chargeurs Réunis, of Paris and Havre, by Swan, Hunter & Wigham Richardson, Wallsend-on-Tyne, is the first merchantman of the French fleet built especially for an all-around-the-world service.

This steamer has the following particulars:

	Meters.	Ft.	Ins.
Length between perpendiculars	147.21	483	
Breadth	16.95	55	8
Depth	10.36	34	
Draft, full loaded	7.32	24	
Gross tonnage (tons)			8,321
Net tonnage (tons)			5,606
Deadweight capacity (tons)			9,500
Indicated horsepower			5,800
Mean full speed on trials (knots)			14.5

The main 'tween decks are very high, which allows the carrying of horses or cattle. The handling of the cargo has been specially well studied. There are not less than fourteen powerful winches, with latest type of derrick accommodations; the most powerful winch can lift 40 tons, and the smallest 5 tons. Everything has been designed for a quick discharging or loading of the cargo.

The ship is fully equipped with the most modern conveniences, including electric light, and a complete refrigerating plant on Hall's CO_2 system, which allows the ship to carry perishable cargo.

The vessel is propelled by twin screws, driven by two engines of the triple expansion, three-cylinder type, which, at ninety revolutions per minute, have developed an average of 5,800 indicated horsepower. The contract conditions as regards speed were somewhat severe, the vessel having to run for a 4-hour full power trial, and subsequently a 24-hour consumption trial. On Sept. 2 last, during the former, the mean

THE STEAMSHIP MALTE IN ST. NAZAIRE DOCK, PREVIOUS TO OFFICIAL TRIALS.

indicated horsepower developed considerably exceeded the guaranteed power; the 24-hour trial was equally successful, the vessel attaining a mean speed of over 14½ knots, the guaranteed speed being only 13½ knots.

The main engines have cylinder diameters of 25½, 43 and 70 inches, and the stroke is 48 inches. The main and auxiliary engines receive steam from six cylindrical boilers of the usual type, being 11 feet 9 inches in length and 15 feet 3 inches in diameter; there are 18 furnaces. The total surface of grate is 366 square feet, and the heating surface 15,660 square feet, giving a ratio of 42.8 to 1. The boilers are fitted with Howden's forced draft system. The normal pressure in the boilers is 200 pounds per square inch.

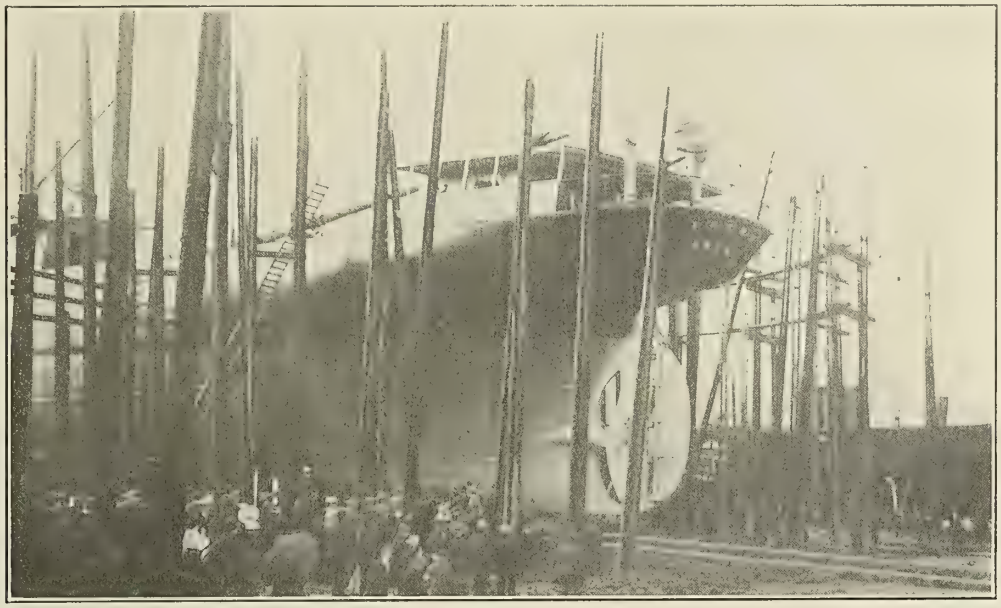
The steamer came to St. Nazaire with 9,000 tons of coal and was measured by customs officials; afterwards she made her official trials for the "subsidy," and then took 5,000 tons of patent fuel for the Saigon dockyard. On leaving St. Nazaire she went to Antwerp, then to Dunkirk, and has left for her maiden trip via Suez Canal, Singapore, Hong Kong, Shanghai and other Eastern ports; thence via the Pacific to various ports on the west and east coasts of South America, and subsequently to the United Kingdom, France and Antwerp. Such a trip is expected to last 240 days.

The Steamship Tosno.

This vessel was built and engined by Earle's Shipbuilding & Engineering Company, Ltd., of Hull, to the order of Thomas Wilson, Sons & Company, Ltd. The ship is intended for passenger and general cargo trade between St. Petersburg and Hull, and is a sister ship to the *Kovno,* which runs in the same trade in conjunction with the *Kolpino.* The *Tosno* is a handsomely modeled vessel, 318 feet long by 41 feet beam and 21 feet molded depth, and has a gross tonnage of 1,985. She maintained on trial an average speed of 13 knots.

The passenger accommodation is of a superior character, and, combined with quick steaming, should make her a favorite boat to and from St. Petersburg, the time occupied by the passage under favorable weather conditions being considerably shortened. There is accommodation for twenty-four first-class passengers, the staterooms being grouped amidships on the

THE STEAMER KOLPINO, RUNNING BETWEEN HULL AND ST. PETERSBURG.



THE STEAMSHIP TOSNO, JUST BEFORE HER LAUNCHING AT HULL.

starboard side. The rooms are large, well lighted and ventilated and are fitted with all modern appliances and conveniences. The saloon and social hall are built of solid oak, set off in panels, and are well upholstered. There is a fine promenade deck over the saloon, also a large poop deck aft, both available for passengers. Large and comfortable quarters have been arranged for captain, officers and crew.

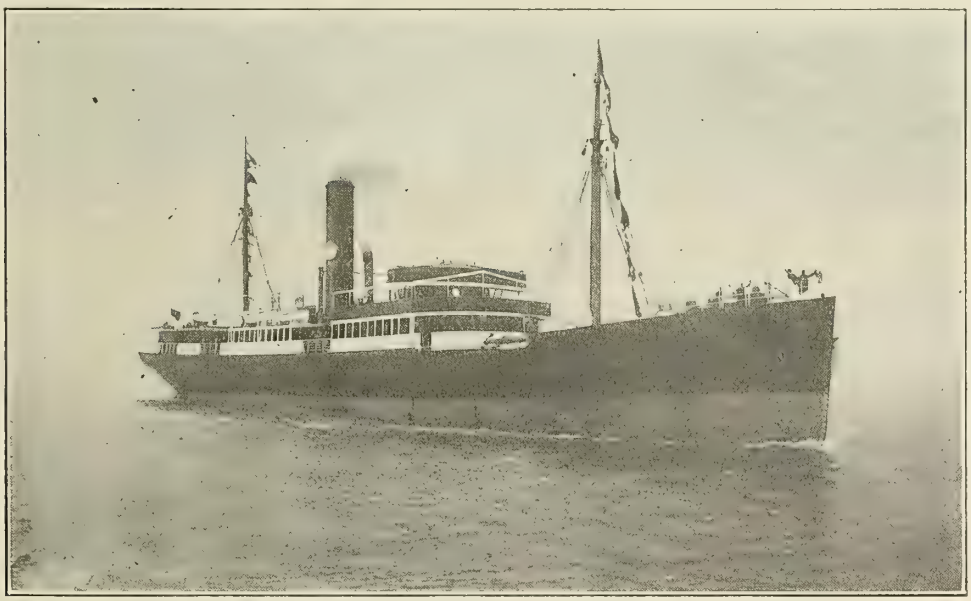
The machinery consists of a triple-expansion engine supplied with steam from two large single-ended boilers working at a pressure of 200 pounds per square inch, and fitted with forced draft on the closed ashpit system. The vessel is lighted throughout by electricity, and is fitted with the latest appliances for expeditiously dealing with cargo, weights up to 15 tons being handled without the assistance of shore cranes.

James Fisher.

A Large Italian Emigrant Steamer.

The twin screw steamer *Venezia,* one of the latest of the Fabre Line, was launched April 30, 1907, from the Neptune Works of Swan, Hunter & Wigham Richardson, Ltd. This steamer was constructed to the order of Messrs. Cyprien Fabre & Company, Marseilles, for their emigrant service between Italy and New York. She is a handsomely modeled vessel, built of steel to the highest class in the register of the Bureau Veritas, and to comply with the Italian and American emigrant regulations. There are eight watertight compartments.

She is propelled by two triple-expansion engines supplied with steam from six large Scotch boilers. Both engines and boilers were also constructed at the Neptune Works, the engines having cylinders 29½, 48 and 77 inches in diameter,



THE STEAMER TOSNO, OF THE HULL AND ST. PETERSBURG SERVICE.

Vickers, Sons & Maxim, Ltd., report for 1907 total profits of £768,525 ($3,739,932), from which an ordinary dividend of 15 percent has been paid.

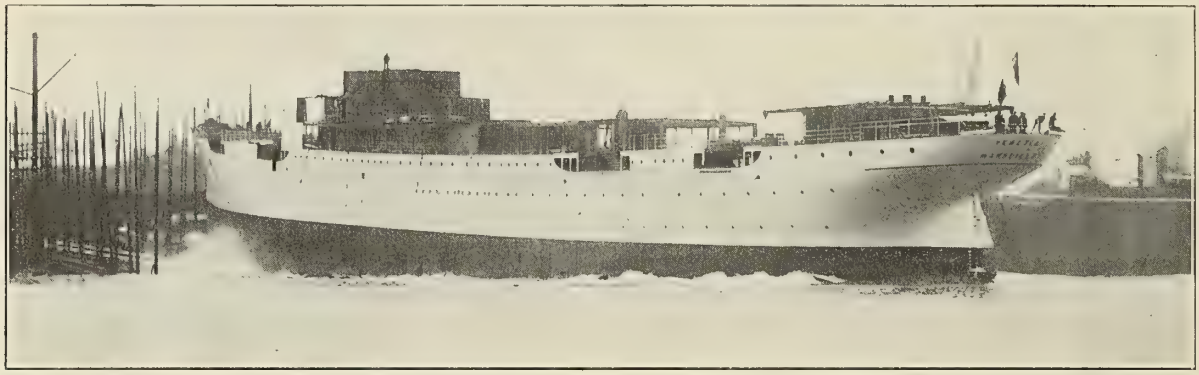
and a stroke of 45 inches. They were expected to drive the *Venezia* at a speed of over 16½ knots, and the trial yielded 17½ knots.

The vessel is about 470 feet in length (457 feet between perpendiculars) by 51½ feet beam and 22¾ feet depth. Her tonnages are 6,733 gross and 3,802 net. She is fitted with accommodation for 50 first class passengers, consisting of a large dining saloon, writing room, smoke room, ladies' room, twenty-four staterooms and one cabine de luxe, all situated in houses on the bridge deck and above. The remainder of the ship is fitted up for emigrants, over 1,800 in all, in addition to which there are hospitals containing sixty beds. J. & E. Hall, London, are the makers of the refrigerating installation fitted on board.

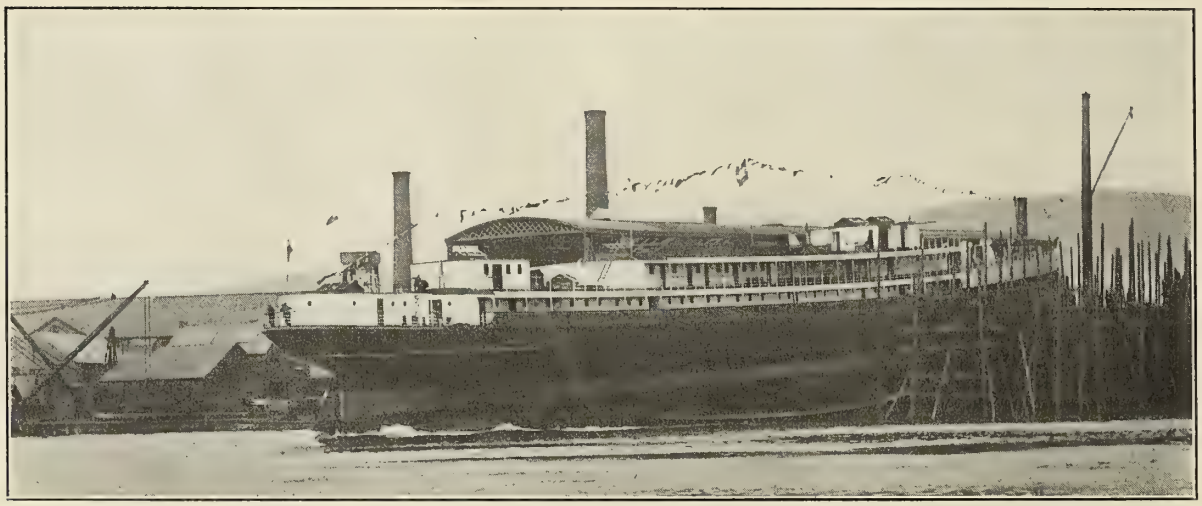
On her maiden voyage the ship reached New York on Oct. 1, 1907, carrying 71 cabin and 1,852 steerage passengers.

and stern. The after rudder is actuated by Brown's patent steam tiller, controlled by telemotor from the flying bridge, and the forward rudder is worked by Hastie's steam steering gear, situated on the rudder head and controlled by large wheel, also on the flying bridge. The vessel has eight large boats carried on a boat deck amidships, and a special steam winch is provided for rapidly hoisting them. All boats are carried on special dropping chocks, which enables them to get clear in a few seconds in an emergency.

The propelling machinery consists of three sets of turbines, on the Parsons principle, all, with the boilers, being constructed by Messrs. Denny. A complete installation of electric light is fitted in the vessel by the builders.



LAUNCHING OF THE STEAMSHIP VENEZIA FROM THE YARD OF SWAN, HUNTER & WIGHAM RICHARDSON.



LAUNCHING OF THE NEW ZEALAND TURBINE STEAMER MAORI AT DUMBARTON.

New Zealand Liner Maori.

BY BENJAMIN TAYLOR.

A turbine steamer, *Maori,* has been built by William Denny & Brothers, Dumbarton, for the Union Steamship Company, of New Zealand. The Union Company, quick to note the advantages of the turbine system of propulsion, was the first to introduce this system to the Southern Hemisphere. Three years' experience of the *Loongana* has justified the step, and the *Maori* is an enlarged vessel of the same type, embodying the results of that experience. The principal dimensions are: Length, 350 feet; molded breadth and depth, 47 and 26 feet.

As the vessel is intended to run in connection with the railways, the appliances for handling her are extremely powerful, and consist of a steam windlass and capstan on the forecastle and a powerful warping winch at the stern, the latter being arranged to work derricks which are provided for dealing with the mails and baggage. Large rudders are fitted both at bow

Being primarily intended for the night mail service between Wellington and Lyttelton, New Zealand, almost the whole of the vessel is devoted to passenger accommodation. There is a shade deck extending from the stem almost to the stern, on which is situated the first class music room, a large apartment designed in mahogany and finished in white enamel. The furniture is in dark mahogany, and includes an artistic music cabinet with bevelled glass panels. The ceiling is in strap work, finished in pale tint. The lighting is by means of large rectangular windows of Broadfoot's make, and by a well in the center, panelled in the Adams style, and surmounted by a teak skylight with stained glass windows. The upholstery is carried out in silk tapestry, with curtains of similar material in pale green and cream shades. The floor is laid with Wilton carpet of a blue tone. Abaft the music room is the principal companion and vestibule, of a classic design, framed in padouk and panelled in figured mahogany. On

either side of the entrance doors spaces are reserved for Maori native carving.

extension, and can be fitted up to accommodate fifty additional passengers in the busy season.

THE TURBINE STEAMER MAORI, BUILT AT DUMBARTON FOR SERVICE IN NEW ZEALAND WATERS.

Amidships, on this deck, is the first class smoking room, of simple classic design, executed in teak and Hungarian ash. The roof of this apartment is raised in the center with a deep frieze in root veneer, a material also used in the dado bands, alternating with panels of figured kauri. The upholstery is in uncut moquette of olive color.

The deck below is the upper deck of the vessel, the forward end of which is devoted to seamen's and firemen's accommodation, with separate messrooms, bathrooms and lavatories, spacious and comfortable. The amidship portion of the vessel is occupied with first class staterooms. In the center is a large vestibule of a design similar to the upper vestibule, framed in walnut.

The main deck is fitted up for first class passengers, from the chain locker as far aft as the forward funnel; also along the port side of machinery space; the starboard side being devoted to the culinary department, which is fitted out with all the latest cooking and baking appliances. The engineers are berthed on this deck alongside of the engine room. The space abaft the turbine hatch is fitted up for second class passengers. The forward end of the lower deck is devoted to the accommodation of seamen, firemen, greasers and petty officers. These have large spaces for their accommodation, and there are not more than eight berths in any one room.

Abaft the forward hatch on this deck is the first class dining saloon, the design of which is of a classical type, executed in mahogany, finished in enamel white. The panels have arched tops, and are provided with a raised ornament. The furniture is in light oak, and here also spaces are reserved for Maori carving. The sideboards are fine pieces of furniture. This saloon is lighted by large sidelights and also by a well, which is treated similarly to the saloon design. The ceiling is in an interlaced design, with narrow panels of anaglypta, finished in pale tints relieved with gold. The upholstery is in uncut moquette. The curtains are of silk tapestry in various shades of pale green, and the floor is covered with Wilton carpet of a rich crimson color.

Abaft the machinery is the second class dining saloon, which is framed in mahogany and finished in white enamel similarly to the first class saloon. The upholstery is in blue and gold carriage cloth. The floor is laid with Brussels carpet runners, and artistic curtains are fitted to the windows. The after end of the lower deck is arranged for a temporary second class

AN INCLINING EXPERIMENT.*

BY HAROLD F. NORTON.

It seems quite the natural thing that a ship should stand up straight in the water, and most of them do, but now and then one does not, and, of course, the consequence is disastrous. For instance, not long ago there was launched at an Italian shipyard a ship which promptly turned over as soon as she was afloat, and sank in deep water, while her builders stood helplessly on shore and watched months of labor and hundreds of thousands of dollars of expense sink beneath the waves. Why was it? What was wrong? If you ask a naval architect he will tell you that she had a negative $G\ M$.

Now, that sounds innocent enough, but it may be seen to be a matter of some importance to determine that a ship has a positive $G\ M$ before she is too fully trusted to the element for which she is intended. Of course, in the books on naval architecture, it may soon be found just what a positive $G\ M$ is, and by what process it is determined that any ship is properly in possession of one, but it may be of interest to know just how the government assures itself that the vessels built for it are all right in this respect, and so I venture to describe the process called an "Inclining Experiment," as performed on one of the late battleships built at the yard of the Newport News Shipbuilding & Dry-Dock Company.

For the benefit of those who are generally interested in engineering subjects, but have not specialized in this particular line, it may be well to explain upon what principles an inclining experiment is based, and how it accomplishes its purpose.

A ship at rest in smooth water, for small inclinations, behaves remarkably like a pendulum (see Fig. 1). That is, it acts exactly as though the mass of the ship, or its center of gravity, were suspended from a point in space which we may imagine to be the center of suspension of the pendulum. This point in space is called the metacenter. Now, calling this point M, the center of gravity of the ship G and the distance between them $G\ M$ (Fig. 1), the importance of $G\ M$ will immediately appear. If $G\ M$ is positive, that is, if the point M lies above G, the ship will stand up straight and true in quiet water, just as the pendulum will hang straight and true if the center of suspension is above the bob. Also, if $G\ M$ is negative, that is, if the point M is below G, the ship will promptly turn over,

* *The Sibley Journal of Engineering.*

just as the pendulum will turn over if its point of suspension is below the bob. Moreover, if the ship is slightly inclined from the perpendicular by any external force and then freed, she will swing back and forth, and finally return to the perpendicular, exactly as the pendulum will. The righting moment, as it is called, will be exactly the same as for the pendulum, that is, the weight of the ship, times $G\ M$, times the sine of the angle of inclination.

$$\text{Righting moment} = W \times G\ M \times \sin \alpha \qquad (1)$$

This is explained from Fig. 1, where righting moment $= R \times O\ M$.

$$R = W \tan \alpha = W \times \frac{\sin \alpha}{\cos \alpha}$$

$$O\ M = G\ M \cos \alpha,$$

whence $R \times O\ M$ (righting moment) $= W \times G\ M \times \sin \alpha$.

Of course, it must be understood that in Fig. 1 the conditions for the ship are exaggerated. For purposes of illustration, the inclination is shown large, and the distance of M above G relatively much larger than would ordinarily be the case. It will be noticed that the ship acts rather the reverse of the pendulum, for if the ship is inclined to the right, G is displaced to the left of the perpendicular through M, and *vice*

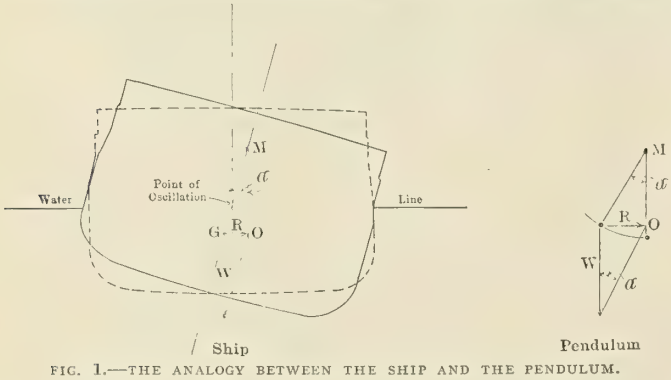


FIG. 1.—THE ANALOGY BETWEEN THE SHIP AND THE PENDULUM.

versa. Also, the ship does not swing about the point M as a center, but about quite another point near the waterline, called the point of oscillation. However, for all static forces involved, she acts as though she were suspended from the point M.

Now the point M is quite easy to locate for any given ship, submerged to any given waterline, from purely mathematical considerations of the form of the ship. Suffice it to say that its distance above the bottom of the ship, or base line, is equal to the moment of inertia of the waterline to which the ship is submerged, divided by the volume of water displaced, plus the distance of the center of gravity of the displaced water above the base.

On the other hand, the exact location of the point G, that is, the center of gravity of the ship's structure and the various things she contains, is extremely difficult to obtain. Of course, it may be approximated by carefully estimating the weight of every member of the ship's structure and every article she contains, summing the moments of all above the base, and dividing by the total weight. In fact, that is the only way to obtain it before the ship is launched and actually afloat in the water, and that is the only way to guard against such an accident as that cited above. However, it is at best a laborious process, and only very approximate. For launching purposes it is ordinarily quite sufficient, for the point G is usually much below the point M, in launching condition. If such an approximate calculation as the above indicated them to be at all close together, special precautions would immediately be taken for the safety of the ship by filling one of her water bottoms, and thus lowering the point G.

After the ship is in the water, the inclining experiment furnishes a ready and easy means of obtaining, with very fair accuracy, the value of $G\ M$ and the location of G. At this time also it is of importance that such an accurate location should be obtained, for as the ship is more and more completed, more and more weights are added, and these are usually weights in the upper part of the ship. The point G climbs higher and higher, of course M climbing also as the ship goes down in the water, and it is of importance to make certain that there is no danger of G's ever catching up with M. Also, when the ship is nearly or quite completed, it is well to perform another inclining experiment. If she is a merchant vessel she is to receive her cargo, and it must be made certain that, whatever its character, there shall never be any danger of a negative $G\ M$. If she is a warship, she is to receive her ammunition, stores and equipment, and the same care must be taken regarding every possible distribution of these. For these reasons the government usually requires two inclining experiments, one soon after launching, and one as nearly as convenient to the completion of the vessel. The one we are about to describe was that performed near the completion of the vessel.

An inclining experiment is based simply upon the principle mentioned in the beginning of this article, that for a small inclination of the ship, the inclining moment, which is, of course, equal to the righting moment, is equal to the weight of the ship, times $G\ M$, times the sine of the angle of inclination. If the ship is inclined by moving a weight across the deck, the inclining moment is simply the weight, multiplied by the distance through which it is moved. Thus, if we call the weight of the ship W, the weight which is moved across the deck w, the distance it is moved d, and the angle of inclination α, we have (see Figs. 1 and 2):

$$w \times d = G\ M \times W \times \sin \alpha, \qquad (2)$$

$$\text{or, } G\ M = \frac{w \times d}{W} \times \cot \alpha.* \qquad (3)$$

Since all the quantities on the right-hand side of equation 3 are known, or may be readily and accurately measured, we have directly obtained a very fairly accurate value of $G\ M$. Then, since we have seen above that the distance of M above the base may be calculated with fair accuracy, we may obtain the distance of G above the base, by subtraction, and any subsequent changes in the location of G, due to weights which must be added, or those which must be removed, may be very closely approximated.

The angle of inclination is obtained by means of one or more plumb-bobs. Battens are fixed at a known distance below the point of suspension of the plumb-bobs, arranged so that they are approximately perpendicular to the plumb lines when the ship is on an even keel, and so that the plumb lines shall hang close to the battens. The point where the line crosses the batten is then marked, and when the ship heels, one way or the other, the deflection of the plumb line from this point is noted. The cotangent of the angle of inclination may then be directly obtained by dividing the distance from the point of suspension to the batten, by the deflection as measured on the batten. This is evident from Fig. 2, where it may be seen that $OA \div AB = \cot \alpha$.

In the experiment we are describing, the weight moved consisted of a pile of pig iron on the upper deck near the midship frame. In order that the weight might be accurately placed, two rows of planks were laid on each side of the deck near the gunwales, so that the half-pigs, when laid across them, came just to the edges of the planks, about as shown. The distance between the centers of the two rows of planks was arranged to be 66 feet. Two plumb-bobs or pendulums were arranged, one forward and one aft, hung from planks laid across the coamings of hatches on the main deck, the lines hanging down the hatches and the bobs swinging just

* Properly, cosecant α, but, for the small inclinations involved, the cotangent is virtually identical with this, and is more easily measured.

clear of the lower platform deck. The battens for measuring deflection were then laid across horses set on the lower platform deck. The lengths of pendulums, or distance from the planks across the main deck hatches, to the battens just above lower platform, were then measured by dropping down a steel tape. The total weight of pig iron was 50.03 tons, and this had been carefully weighed and divided into two sections of 25.02 and 25.01 tons, respectively, the pigs of one section being marked with white, and those of the other with black paint, to distinguish them.

The experiment was started with all the weight piled on the port side of the ship. Half of it, the white pigs, 25.02 tons, was then carried across and laid on the starboard side, and a reading taken of the movement of the plumb lines across the battens. The remainder was then carried across to the starboard side and another reading taken. This half, the black pigs, was then carried back to the port side, and another reading taken. The white pigs were then carried back and a final reading taken. The results are set down in the table. It will be seen that the return readings checked very well with the first, those on the forward pendulum being exactly the same, and those on the after one very close.

Of course, it must be explained that, in preparation for the inclining experiment, the ship had been carefully gone over to see that there was no free water anywhere, and to take account of all weights on board which were not to remain there ultimately, or of any which were lacking to bring the ship to a completed condition, in order that proper allowance might be made afterward in calculating the $G\ M$ of the ship as completed. In the same way, it was necessary to deduct the weight of the pig iron used in inclining, the weight of the men employed to transport the pig iron across the deck, and of those occupied in directing the experiment and observing the pendulums. All other men were, of course, excluded from the vessel, and at the time readings were taken, all those on the ship were required to stand near the centerline, in order that even this small weight might not affect the readings.

INCLINING EXPERIMENT.

Ship as Inclined.—Practically completed, except certain battery weights and magazine equipments; no boats on board; some coal in bunkers; no water in bottom, bilges or tanks.

Draft.—Forward 21 feet 6¾ inches, aft 24 feet 6¼ inches, mean 23 feet ½ inch.

Density of Water.—Cubic feet per ton, 35.48.

Displacement.—Corrected for trim and density of water, 14,685.54 tons.

Inclining Weights.—50.03 tons on upper deck.

Pendulums.—Forward, length 370.50 inches, hung from main deck frames 18 and 19.

Pendulums.—Aft, length 377.75 inches, hung from main deck frames 94 and 95.

Inclinations.	Weight Moved (Tons).	Distance Moved (Feet).	Moments of Inclining Weights (Foot-tons).	Deflection of Pendulum (Inches). Starboard.	Deflection of Pendulum (Inches). Port.	Length of Pendulum (Inches).	Cotangent	Mean Cotangent.	G. M. (Feet).
1st... For'd				10.25		370.50	36.15		
1st... Mid's	25.02	66.00	1651.32					36.40	4.093
1st... Aft				10.31		377.75	36.64		
2d.... For'd				10.13		370.50	36.57		
2d.... Mid's	25.01	66.00	1650.66					36.48	4.100
2d.... Aft				10.38		377.75	36.39		
3d.... For'd					10.13	370.50	36.57		
3d.... Mid's	25.02	66.00	1651.32					36.28	4.079
3d.... Aft					10.50	377.75	35.98		
4th... For'd					10.25	370.50	36.15		
4th... Mid's	25.01	66.00	1650.66					36.48	4.100
4th... Aft					10.25	377.75	36.80		
Mean metacentric height									4.09

In order that the inclinations might not be affected by the ship's touching a pier, or by the pull of any lines, she was hauled out between two piers quite clear of either of them, and all lines were slacked at the time readings were taken. Also, care was taken to choose a time for performing the experiment, when there was little or no wind, and the water was perfectly quiet.

The drafts forward and aft were carefully read, the density of the water tested, and the exact displacement taken from the displacement curve, with due allowance for trim and for

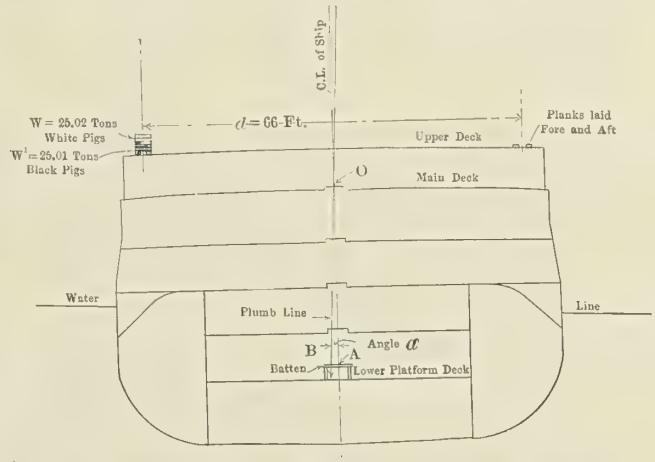


FIG. 2.—OUTLINE SECTION, SHOWING INCLINATION TO SCALE.

density of the water. This displacement, 14,685.54 tons, was then used in obtaining the values of $G\ M$ set down in the table. For instance, for the first reading:

$$G\ M = \frac{w \times d}{W} \times \cot \alpha. \qquad (3)$$

$w \times d = 25.02$ tons $\times$ 66 feet. $= 1{,}651.32$ foot-tons, moment of the inclining weight.

$$\cot \alpha, \text{ for forward pendulum} = \frac{370.50}{10.25} = 36.15,$$

$$\cot \alpha, \text{ for after pendulum} = \frac{377.75}{10.31} = 36.64.$$

Mean $\cot \alpha = 36.40$,

$W =$ displacement $= 14{,}685.54$ tons.

$$G\ M = \frac{1{,}651.32}{14{,}685.54} \times 36.40 = 4.093 \text{ feet.}$$

It is not universally conceded to be good practice to begin the experiment except with the ship on an even keel. There seems very little valid objection, however, to beginning as above, with the ship inclined to one side, except that it is not practicable to set the deflection battens accurately perpendicular to what will be the hang of the plumb lines when the ship is on an even keel, and the drafts cannot properly be read before the experiment begins. If, however, the deflection battens are placed parallel with a deck, they will be so nearly perpendicular to the plumb lines, with the ship on an even keel, that considering the great length of the pendulums and the comparative smallness of the deflections, the error is practically negligible. If, then, the draft readings are taken when half the weight is on each side, the above method of performing the experiment would seem to possess no special disadvantages, and it has the great advantage of convenience, since the weight may all be hoisted directly from a pier to one side of the vessel, at the beginning of the experiment, and when the experiment is over it is all back on the same side, ready to be lowered to the same pier.

SAIL MAKING.

BY ADRIAN WILSON.

There is, without doubt, a limited demand for some good, reliable work on the making of sails. Only one or two books have been written on the subject, and they are really of no use to the ordinary yachtsman, and of little practical value to a sailmaker. What little has been written applies only to the making of square sails used on merchant ships. The only valuable book of this kind is one written in England by a practical sailmaker named Dice, on the cutting and making of jibs or headsails. It is a book of real value, as it treats of the matter in a really practical and scientific manner. Mr. Dice's ideas we believe to be original and his conclusions sound; and, having put many of his ideas to practical use, we have proved them to our satisfaction to be of value. All other works on the subject we have found to be simply useless to anyone except a practical sailmaker. These works, as a rule, consist of a lot of matter used by the ordinary master sailmaker in laying down and cutting sails. If read by the ordinary yachtsman he would probably know about as much in regard to sail making at the start as he would at the finish. I am of the opinion that any attempt to write up the subject, so as to make it an intelligent or enlightening book, would result in a failure. There are so few to whom it would be of real benefit that it would be a useless waste of time.

In our work as sailmakers we have learned, through long experience, certain established facts and principles that are of great value to us and also to our customers. One trade secret is worth more than all the patents ever issued. Through long experience and accumulation of certain details we have collected together much valuable data in our line of work; especially has it been our good fortune to get the facts together through our experience in making sails for racing yachts. Opportunity has presented itself by our ability to see the sails in actual use and in all conditions of weather. This opportunity, together with the training of intelligent workmen, has enabled us to direct the cunning hand of skilled mechanics to produce results which have turned out racing sails that lead the world in attainment of speed in sailing yachts.

While we have made it a point for years to say as little as possible about the cut and making of American racing canvas, we believe the time has come when the protection of our interests makes it necessary that we put something into the hands of our customers that shall give them an intelligent understanding of why we do certain things, and shall help them to carry out, in the use of their sails, the work begun in the sail loft. It is a fact that more poor sails are made on yachts than in sail lofts. By this I mean that as much, or even more, depends on the intelligent handling of sails as in their making. The sailmaker can use all of his skill in the making of a racing suit, and spend days on its construction, yet it may all be lost, or thrown away, by the handling it receives when put on board the yacht.

Now comes the question as to what are the principal elements of the best racing sail; on what principle is it constructed that gives it real value as a racing sail? There are some very opposite opinions on this question. It has been a question for some years as to the superiority of English vs. American sails, or *vice versa*. On this point are two directly opposite opinions. The English designers and sailmakers believe in a flat surface or straight plane for the fore and aft body of their sails.

ON THE WIND.

THE FOUR-MASTER AFGHANISTAN
(Photographs, N. L. Stebbins.)

BROADSIDE VIEW.

THE SCHOONER YACHT DERVISH. (Photograph, N. L. Stebbins.)

At the time the yacht *America* sailed her famous race at Cowes, the English yachtsmen were thoroughly convinced that her victory was due to the fact that her sails were perfectly flat. This was not a fact. The sails of the *America* were made by the writer's father, R. H. Wilson, of Port Jefferson, N. Y.; and while, in comparison with the sails made in

England at that time, they had the appearance of perfectly flat planes, they were in reality no such thing. There was a certain curved line in these sails that was almost as near the correct thing as it was possible to make, and no improvement has been made in sails from that day to the present time; nor is it possible to improve on them, as this curve or draft was about as nearly perfect as possible. The *America's* sails were made of cotton duck, especially made for this suit of sails by John Colt, of Passaic, N. J. The superiority of this fabric over the flax or hemp duck used on the English yachts, which was a soft, flabby material and cut with a great amount of bag, was at once demonstrated by the ability of the *America* to out-point and out-foot the English boats.

If the reader cares to look up the records of the races sailed for the *America's* cup, he will find that all of the American victories have been due to the fact that the American boats are faster in windward work. In some of the later races sailed for the cup the English yachts have shown that they could do better than the American yachts in both reaching and running,

We would begin by giving our readers our experience as to the best forms of sails. Some of our measurement rules are directly responsible for badly proportioned sails. I have always contended that sails should be measured by their actual areas, and should not be computed from measurements taken by measuring the spars. The Massachusetts Yacht Racing Association has adopted this method for several years. The canvas in a sail is measured and the spars are not, so the boat is taxed only for the actual area she has in her sails, and the spars can be made sufficiently long to insure the proper setting of the sails. The restrictions are put on the light or balloon sails. The same question arises in almost any rule. The new rule, under which we are to-day building the Class "Q" boats, is productive of an abnormal sail plan. The designer is forced to produce a high, narrow-headed sail, of which I shall have more to say later. The tall, narrow plane has some very serious faults that should not be carried to the extreme they are in the Class "Q," and especially the Sonder Klasse.

DOUBLE TOPSAILS AND TOP GALLANT SAILS.

A SHIP WITH DOUBLE TOPSAILS, ON THE LONG OCEAN SWELL.

BARK WITH DOUBLE TOPSAILS.

(Copyright photographs, Lamson Studio.)

but as soon as any windward work begins the latter immediately begin to show their superiority. I contend that any boat that can show speed in reaching and running should be able to do the same in windward work, provided she is as well clothed as her antagonist.

We see much written to-day by yachting experts on the draft in American sails. We are inclined to think that too much has been written on this very point, and we are giving points to the other fellow that we had better "keep up our sleeve" for another day. I must say I am not at all in sympathy with the idea—no matter how good a fellow our opponent may prove himself to be—that we should immediately turn over to him the full working plans of our winning boat, and also present him with a suit of American sails. Why, it would be a grand idea to present to a "jolly good fellow" on the other side of the "pond" the *Reliance,* the fastest craft afloat, and ask him to challenge again!

In our work as makers of sails for some of the most famous boats afloat, we have learned many valuable points and collected much valuable data, and we propose to keep it to ourselves. It is our stock in trade; but, as I have said, we can give our friends much valuable information that will be of real value to them in the handling of their canvas.

The idea of draft in a sail does not mean that the sail should be a bag, or approach bagginess in any degree. There is a vast difference in the meaning of the two terms.

The theoretical idea of a sail being a perfect plane is carried to the extreme in all sails of English manufacture. We believe that the idea of a sail being a perfect plane, starting at the luff or mast and going in an absolutely straight line to the leach, giving a surface that allows the wind current to pass across the sail and escape at the after leach, is not correct. But if the sail can be so constructed that the wind entering into its surface strikes the sail at an angle slightly diverging from its true course or direction, it strikes the sail with a greater impulse, and should give the sail more push.

To put it in a plainer way, here is an illustration of the idea I wish to convey. Suppose the boat is laying at a mooring with sail set perfectly smooth, and is directly in the wind. If at the point of center of effort of the sail a cross should be marked on the surface of sail, and a plumb line dropped from the gaff, crossing the mark at center of effort—we are supposing the boat to be laying directly in the wind—if she be payed off on either tack so that the sail becomes filled with wind, the cross marked on the sail would immediately move forward of the plumb line. Now, we claim a sail should have

incorporated into its construction in the forward body enough fullness or freedom in its surface to accomplish the above result.

As I have already said, there is a vast difference between the terms "draft" and "bag." A sail so made that it shows only one curve, or the segment of a circle, in its surface is entirely wrong. That is "bag." "Draft," properly described, means an elongated parabolic curve, or a curve commencing in the luff or windward part of the sail next to the mast in

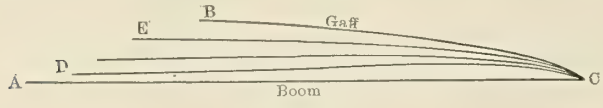


FIG. A.

a parabola, continuing into a nearly straight line to the after leach. But still further, the after part must not be too hard and flat. At its outer part it should still show some considerable freeness, so that the after edge of the sail may not in any sense show a tendency to hold at all to windward of the true ending of the elongated curve, as shown in Fig. *a;* where *A* is the boom, *B* is the gaff, *C* is the mast, *D* is one-third of distance from boom to gaff, and *E* is two-thirds of distance from boom to gaff.

The illustration is simply to give an idea of what we mean by draft, and how it is distributed in the sail. Now, the amount of draft to be put into a sail depends to a great extent on the shape and proportions of the sail, and the shape and proportions of a sail should depend to a great degree on the locality and conditions in which it is to be used. I now refer to a paper read at the Massachusetts Institute of Technology, and include with this a copy of the same as follows:

Before going into the discussion of shape and proportion of sails, one other consideration must be given, as to the different conditions under which a boat may be used. By conditions under which she is sailed I mean weather and locality, and in using the word conditions I wish it understood as referring to the strength of the winds. In our experience as sailmakers almost the first question we ask a customer is: "Where do you use this boat?" We have found that it makes a vast difference as to the location, for at the different points along our coast we find the weather conditions so entirely different as to cause us to make very different recommendations for a sail made for use in Buzzards Bay or Long Island Sound or at Marblehead. In our opinion the sail plan for a 21-footer for use at Marblehead should be quite different from one for use in Buzzards Bay.

At Marblehead the weather conditions are such that we would recommend a very high, narrow plan, while at Buzzards Bay we would recommend a lower, broader plan for the same design. The conditions at Marblehead are, on an average, light winds. Also, the wind currents are high up from the water, and what might well be called streaky currents, the wind being found in veins, a peculiar feature of this locality, especially in light winds. I have no real authority for this statement, but should judge that my statement would stand some test. At Buzzards Bay the prevailing winds are southwest, and strong and heavy, the sea breeze blowing in damp and strong. As we ship our sails to many different localities, we find it quite to our advantage to inquire ineo and study these conditions.

Possibly San Francisco Bay may be an interesting example of these conditions. At first it was a difficult problem with us, and, in fact, it took about two seasons for us to accomplish the best results there. The conditions there are peculiar, in that the trade wind blows directly into the harbor and generally right up the bay, taking the channel or center of the bay. Starting out from the city side of the bay, a yacht will have a soft, light wind blowing from 4 to 7 miles an hour. As she approaches the channel or center of the bay she enters the strong current of the trade wind until, reaching its center, she has a wind of from 25 to 30 miles an hour, and goes out of this as she reaches the other side of the bay. So, practically, she sails from a light wind through a strong one into another light wind, and here we find a double condition to contend with. Sails made for use in these waters are really a compromise between what we would make for the two conditions alluded to earlier. Knowing the conditions of weather under which the boat would sail, it would be a choice of either one of the plans mentioned—that is, the high, narrow plan, the low, broad plan, or a compromise between the two.

Let us consider first the important characteristics of the light-weather sail plan. In all of these plans the angle of the

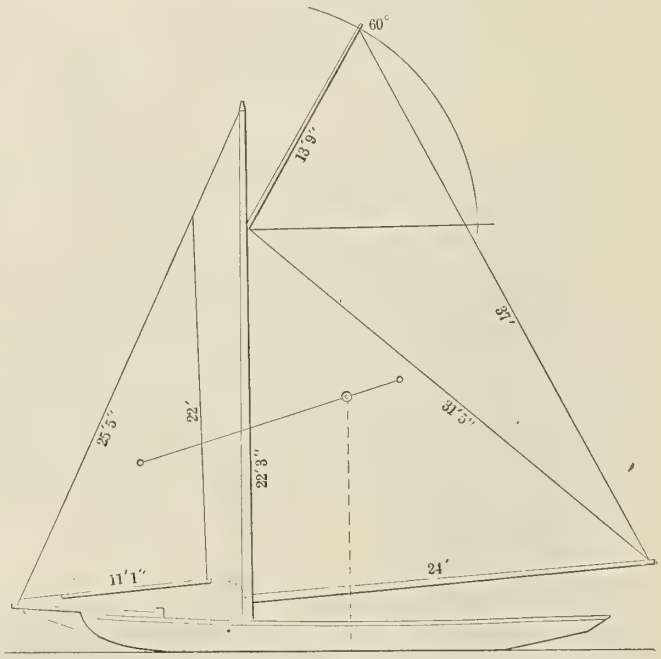


FIG. 1.

gaff or peak of the sail is a most important factor, and is deserving of the greatest consideration. We have found from experience that the high, narrow sail will not bear so high an angle of peak as the low, broad sail plan. In order to get the best results for light conditions, it of course becomes necessary as the hoist is increased to shorten the gaff, and take 65 degrees maximum and 50 degrees minimum as a basis for all peak angles. As I say, taking 65 degrees as a maximum, as the hoist is increased and the gaff is shortened, the angle of peak should be lowered. I am speaking of a restricted area.

In the present raceabout class, an angle of 60 degrees on the following dimensions of mainsail will be found to give the best results: Hoist, 22 feet 3 inches; head, 13 feet 9 inches; foot, 24 feet, and leach 37 feet; 480 square feet in the mainsail and 120 square feet in the jib. The illustration before you is what we consider one of our best 21-footer sail plans for light conditions. In the proportioning of one sail to the other, or in dividing the area into the two sails, mainsail and jib, this plan is a very excellent one, and shows the result of careful study as to the best result to be obtained in dividing the 600 square foot area. (Fig. 1.)

To make a comparison of one or two plans I will take first one of our champion 25-footers, and illustrate the point as to overpeaking the mainsail by explaining how at first this was a very unsatisfactory sail, and, by a slight alteration, was so greatly improved as to make the boat an easy championship winner. The sail as seen by myself, under almost ideal

conditions, was far from satisfactory, and had a very serious fault in that it showed entirely too much bag in the upper forward angle of the sail. If the peak was set up to the angle at which it was designed, the sail had the bad fault mentioned, and the yacht had to be kept off to allow the sail to be kept full of wind. Now, in order to lessen the bag mentioned, the peak was dropped, with the result that the gaff swung off to leeward, and then the boat would not reach as fast as she should. The correction was made by cutting down the angle of peak 6 degrees, with the result of getting an almost ideal sail. (Fig. 2.)

With the amount of area divided into the two sails of a jib and mainsail rig, care should be taken to so place the sails on the boat that one will be entirely independent of the other;

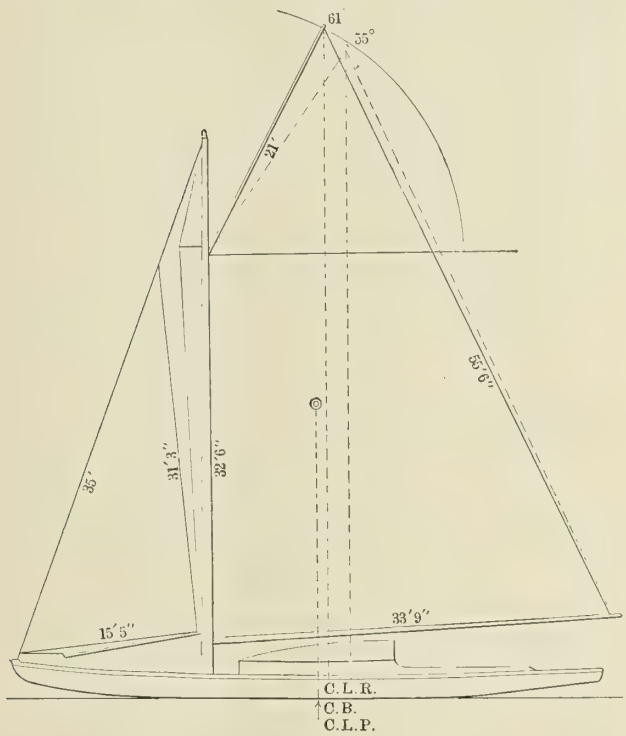


FIG. 2.

that is, it will be found of much advantage if the jib is placed far enough forward so there can be no draft of wind or air current passing from the headsail to the lee side of the mainsail. If the two sails are so close to each other that the current of wind from the jib strikes the lee side of the mainsail, it is more than likely to lift the forward part or luff of the mainsail out to windward, and, of course, that part so affected is a dead loss to the boat. The sails should be so placed that every inch of the mainsail may be doing its full work. Especially should the head of the jib be kept well away from the mast, as the upper part or the head of the jib is much nearer the mast than it is at the deck. Also, the upper part of the mainsail is at a broader angle than the boom. So you may readily see the importance of keeping the jib clear of the mainsail.

In designing headsails, this question of one sail interfering with the work of another is of great importance. In a plan where the head area is divided into two sails, this question should receive great consideration. In our older plans of boats, designed and built fifteen or twenty years ago, when the double-head rig or cutter rig first came into use, we at first had a great deal of trouble in getting satisfactory headsails, and the greater part of the trouble was from the cause I have just mentioned.

On a single-masted boat the headsails are called forestaysail and jib, but properly speaking they are really foresail and jib, as the name forestaysail should really apply to the first sail forward of the masts on a schooner. In either rig, sloop or schooner, the two sails must be so arranged as to have the least interference possible with each other. Care must be taken to keep the jib from coming too close to the forestaysail, and one way to succeed in this is to be careful not to get the points at which the two sails attach to the mast too close to each other.

The jibstay should be a very considerable support to the masthead. And the forestay, while being kept as much as possible clear of the jibstay, should not be placed so low down on the masthead that the strain of the halyard in setting the sail may be in any way likely to assist in pulling forward that part of the mast near the jaws of the gaff.

The boom should be placed high enough from the deck so that the helmsman may have a good opportunity to see out under it at almost any angle of heel. On a 21-foot raceabout, 18 inches is a convenient height, and at the taffrail 3 feet should make a good, convenient clearance, and also keep the end out of the water when running with a free wind. Now, in getting the right length of mast for a boat of this class, or any class (as this rule will invariably apply in all cases), do not lose sight of one very important point—the lower peak halyard block should never be lower than a level line drawn through the center of the gaff. This will always insure your being able to hold the peak up to its proper position. The lower peak angle will, of course, have a greater tendency to thrust or push against the mast at the jaw of the gaff than the higher angle. Should this occur it can be remedied by a strut and stay on the forward side of the mast, which has been adopted on almost all classes of racing yachts to-day, from the 15-footer to the 90-footer, and with this arrangement of rigging the spars can be made much lighter in weight.

The jib on a 21-footer is of the following dimensions: Luff, 31 feet 5 inches; leach, 22 feet, and foot, 11 feet 3 inches; the intersection of the foot and leach being the point nearest to the mast, this distance on the plan I am discussing at this point being 2 feet 4 inches and the head 3 feet from the mast; so you may readily see the care taken to prevent the jib throwing any wind under the lee side of the mainsail. Of course we would not carry this out on a larger boat, as it would not be practical on a sloop or schooner, especially one of size. Possibly I might have covered this point in fewer words by saying, "in planning your headsails do not make them lap one over the other any more than necessary." I firmly believe that the best jib is one that does not lap by the forestay at all. In headsails the foot should be cut high, the forestaysail well up and clear from the deck. Also, the jib should have a high clew (this is the point where the leach and foot intersect). The nearer a jib on leach and foot approaches the same dimensions, the more perfect will be the sail, and especially is this true of jibtopsails. While all of our knowledge on this matter has been gained in a practical way, it has been almost the work of a lifetime to educate yachtsmen and designers to these facts. In making plans for schooner rigs, it has become almost a custom to place the mainmast at about the midship-section, which on most of the modern plans will be found near the center of the waterline. The foremast will come nearly half way from the mainmast to the stem of the vessel, and on almost all of our schooner plans I find the center of effort will be found just about at the forward side of the mainmast, and the center of lateral resistance from 18 inches to 2 feet aft of this.

The custom of making the mainmast longer than the foremast I also find falling into disuse, and on almost all of our new plans you will see the two masts of about the same height, with some little difference in lengths of the topmasts. The rigging plan should also be a part of the sail plan, as it is

most important that the mast and other spars be held as straight and firmly as it is possible to make them. As soon as a mast or boom or gaff begins to bend or buckle out of shape, just so soon is your sail out of shape and losing its efficiency. The shrouds should be placed, one from the top of the masthead leading forward of a center line of the mast to hold the masthead from springing back, and one from a point as near as possible to the jaw of the gaff, leading aft to hold against the forward thrust of the jaw of the gaff. The jibstay and upper shroud should hold the mast from coming aft. The lower shroud and runner should hold the mast from coming forward.

Another important point in relation to your sails is to properly trim them. Knowing after a trial at about what angle the main boom should be, great care should be taken to get the head sheets so arranged that they will work to the best advantage with the mainsail. The head sheets should not be too broad or too flat, and in planning them care should be taken that their shape and proportions are so arranged as to have them sheet at convenient places on deck, or, in the case of the jib, on the rail. Many a boat has never shown her best speed for the reason that her headsails were improperly shaped, or not trimmed at the right angle for their best work with the mainsail.

Now, in making a suit of racing sails it is our custom, starting with the sail plan of the yacht, to make a cutting plan of each sail. We cut all of our sails on the floor. We first make a plan of the sail, drawing in the curves or roaches, as the sailmaker would term them, for each side of the sail. It would be impossible to cut a sail by laying down simply a set of straight lines. The body of the sail is not a flat plane. Consequently it becomes necessary to give it form by laying outside of these straight lines some curves whereby the body of the sail may have some draft or curved lines that make a perfect sail. We have from our data established a scale of percentages that we use to give us the amount of curve we shall put into the foot or boom part of the sail, also in the mast or luff, head or gaff and leach. These curves, properly determined, are put on the plan, and the same is laid down on the loft floor. The cloths are carefully cut to these lines, great care being used to know that the same amount of tension is applied to each cloth. Each cloth is pinned to the floor until all are cut. Next comes the careful marking of each seam. The cloths are laid one on each preceding one and marked at every foot for the machine or hand sewer, and the foreman makes it his business to see that the marked spaces are carefully matched in the sewing, whether sewed by machine or hand.

After the sail is carefully sewed together it is again spread out on the floor, and each seam is carefully ironed out so that it may come to the original dimensions. In hand-made sails the greatest care is taken in this detail, as it occurs in hand sewing that a certain amount is taken up in sewing the sail. The seams, when the sail is spread out on the floor, are carefully ironed out as smoothly as possible. The finished dimensions are then laid down on the sail, and the lines of roach or curve to be put into the sail are marked. The part that is outside of these dimensions is what the sailmaker would call the "tabling." Outside of the sail loft it would be called a hem. Herein lies a point about which we are very particular. The strips or tablings are laid back on to the sail to make the hem or strengthening pieces around the edge of the sail where the rope will be sewed on. It is not our custom, as with some sailmakers, to put on the edge of the sail straight bands of duck for tablings, as we have found from experience that these bands will not stretch evenly with the sail, and so we provide bands cut from the sail as described, so that each thread in the band may lay parallel with the sail under it, insuring an even stretch to both parts. These tablings are carefully basted to the sail, and sewed either by hand or machine, as the case may be. All of our lighter sails are made by machine in these days, and our heavier sails are made by hand. We do many things on the hand-made sail that can be accomplished only by the cunning hand of the skilled workman.

After the sail has been tabled or hemmed, the eyelets are inserted by which it is bent to boom, gaff and mast hoops. It is then turned over to the roper, and herein lies the finest part of the whole business, and the success and future of the sail. Only the very best and most skilful workmen are employed on this part of the work. He must be a man of good judgment, and able by his skill as a workman to put into his work the idea of the master. The ropes are carefully stretched and marked at spaces of 1 foot, like marks being placed on the sail, and where there is more rope than canvas wanted for a certain space, or the opposite, as the case may be, the workman shall be able by his skill to sew the two together to the satisfaction of the foreman.

The bolt ropes vary on the different sides of the sail as to size, and how they are roped on to the sails. Years of experience have taught us that the best bolt rope for yacht sails is the imported Russia hemp bolt rope, made by Hoth, of St. Petersburg, Russia.

All duck or canvas will stretch. The amount of stretch depends on the material or fiber of which it is woven. Up to about the year 1840, or thereabouts, all sails had been made of flax. If I am not greatly in error, the first sail made of cotton was about the year 1832, and the first cotton to be used in sails was worked up in New York city. The flax duck used up to that period was very similar to the flax in use to-day. Most of this material was made in Holland, and was known as Holland duck. It is used in England and on the continent to-day for sails for ships and coasting vessels. Up to the coming of the yacht *Thistle,* the English sailmakers had used flax duck for their racing sails, although of a quality much superior to that used for commercial purposes. In fact, it is in use to-day in England for cruising yachts.

The great advantage of cotton fiber over flax is that it does not stretch so much, and will not come and go to such an extent with the changes of the weather; that is, when subject to dry, hot winds, will give or stretch but very little as compared with flax. With the adoption of cotton in the making of canvas for sails, there was also put into practice in this country the lacing of sails to the boom. As I have said, any piece of canvas will stretch, one principal reason being that duck is constructed on what the weaver calls a plain weave or basket weave. It is made by two sets of yarns, one known as the warp, or those threads which form the length of the piece of goods, the other set being the weft or filling thread. In

FIG. B.

weaving a piece of goods, the warp is comprised of two sets of threads, the upper and lower. The filling or weft passes between the two warp threads. The warp passing up and down on the weft or filling has some considerable corrugation put into its length, as can be seen by Fig. *b,* which shows the form of a piece of canvas if cut lengthwise, the circles showing as the ends of the wefts or filling, and the warps showing as corrugated.

In weaving a piece of ordinary canvas, the weaver would make an allowance of nearly 25 percent for take-up in the warp; that is, if he wishes to make a piece of canvas 100 yards long, he would require 125 yards of warp thread. In the weft or filling, the thread laying nearly straight in the goods, the take-up would be about 10 percent. Before being put into the loom, a certain amount of twist is put into both of these

threads, as each is comprised of a multiple of smaller single yarns. This is called doubling, and as the number of doublings, so is the number of twists per inch. This is a mathematical problem, and is worked out by the weaver on that principle. This twist put into the yarn gives it a certain amount of spiral. The more twist or spiral it contains, up to a certain point, the more will it stretch. Take a number of small threads and lay them parallel. Also take the same number of threads and twist them up a number of times or twists, and you can easily see that the twisted threads will give or stretch more than the straight ones. The twist is necessary to give the required strength to the fabric.

If we take a piece of duck or canvas of a certain length and subject it to a strain, it will, if pulled lengthwise, stretch, for the reason that the corrugation caused by the weaving process, and also from the spiral caused by the twisting of the single yarns together, give and stretch; but, while it stretches in length, it will, at the same time, become narrower. As it goes out lengthwise, it will come in crosswise.

As all duck will stretch more lengthwise than crosswise, we have of late years adopted a method of making sails which we term crosscut. Formerly it was our custom to arrange the cloths parallel with the after leach, and we had to make considerable allowance for stretch. In crosscut sails—or those sails which have the cloths or seams arranged at a right angle to the after leach of sail—we have put that part of the goods having the least tendency to stretch to the line of the greatest strain. The greatest strain to which a sail is subject is from its clew, or that corner of the sail attached to the outer end of boom, on a line drawn from that point to the center of effort in the sail. That we have a smaller amount of stretch to contend with in crosscut sails than in the old style of cloths arranged parallel to the after leach is a fact, and makes the problem a much easier one for the sailmaker.

(To be Continued.)

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

HEATING BY WARMING THE AIR ENTERING THE ROOM.

The tendency of modern heating appliances, both on shore and afloat, is to warm each room individually, each cabin, saloon, corridor, etc., by warming the air entering the room, or a certain portion of it. As will be explained in dealing with ventilation, the latest application of the system combines heating and ventilating. The ventilating air current is made use of to warm the room by being itself warmed before it enters the room, and similarly the air may be cooled before entering the room, and so keep the temperature down.

There are several methods of warming the air entering the room in which the appliances that have been described are made use of, with slight modifications that will be explained, and in addition to these the whole of the air is warmed by special apparatus, as described above. One of the methods that have been developed on shore is by causing a certain quantity of oil to be heated by the stove, or fire grate, as explained below, and to be delivered into the room at a higher temperature than rules outside.

SPECIAL AIR-HEATING STOVES.

On shore a number of stoves have been developed that are doing very good work in hospitals and other institutions, in which a certain quantity of air is warmed before it enters the room by being passed over a hot surface, specially arranged for it, in the grate or stove with which the room is heated in the ordinary way. The arrangement of the grate is shown in section in Fig. 48, and a complete stove is shown in Fig. 49. This is the form made by George Wright & Company, Rotherham. (See next page.)

It will be seen that in place of the fireplace extending right to the back of the chimney, there is a space behind that devoted to the burning fuel within the chimney proper, and that the hot gases, smoke, etc., from the burning fuel are taken up through an iron flue inside the chimney proper instead of being delivered straight into it from the fireplace. Air is led between the flue and the chimney space from the outside, usually by a duct leading from the outside air through one of the outside walls in the neighborhood, where a grating is provided that can be arranged to regulate the quantity of air entering. The cold air from outside passes through the duct over the hot surface of the back of the fireplace and that of the flue above, and is delivered into the room through gratings provided for it at the level of the usual chimney breast in front, and sometimes also at the sides.

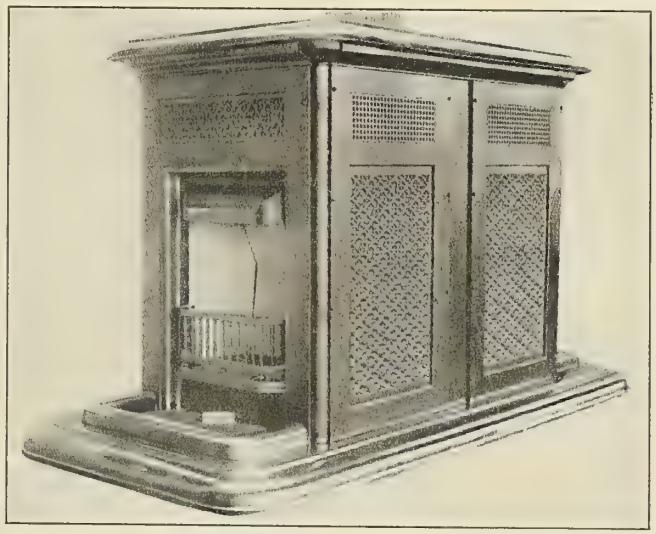


FIG. 51.—WARM AIR VENTILATING GRATES (GEO. WRIGHT & CO.)

In the large hospital stove shown in Fig. 51 the air is delivered from the front, sometimes the top, and always the sides, and it is a common thing for hospital wards to be warmed by a stove of this kind at the end farthest from the door, and one or more pairs of similar stoves standing back to back in the middle of the ward, at a certain distance from the door. Stoves of this kind are made for smaller rooms as well as for the large rooms of which hospital wards usually consist, and it appears to the writer that they could be very well adapted for heating the saloons, mess rooms, etc., on board ship, the air to be warmed being taken from above the upper deck by a ventilating arrangement, properly protected in the usual way, and brought down at a little distance from the stove and then run in under the deck to the air space described.

A modification of the air-heating stove, which has been used in a school, but which is somewhat crude, consists of a stove of the usual slow-burning type, standing near the middle of the school room, with a chimney carried vertically to within a few feet of the ceiling, and then carried to the outer wall at an angle a little above the horizontal, the chimney being continued outside the outer wall in the usual way. The nearly horizontal portion of the flue has a second cylinder surrounding it, into which air is brought from outside at the point where the flue emerges, and the air is warmed by its passage through the annular space between the flue and the surrounding cylinder, and is delivered to the room above the stove, warmed to a certain temperature.

The arrangement of the air-heating stoves mentioned for

hospitals is a great favorite with some of the superintendents, because they say that the firegrate gives the ward a certain cheerfulness, and the matter of heating the air is fully provided for by the arrangement described. The radiation from the dancing flames of the ordinary cheerful fire has also an important bearing upon the subject. The yellow flames that the Anglo-Saxon so likes to see give out light rays principally; but, according to the latest experiments, the light rays are converted into heat rays after passing through the skin and warm the body, while the red rays and the dark or invisible heat rays do not pass through the skin, and have therefore no useful effect, unless they are made to impinge upon something that will absorb them, such as the furniture of the room. The hospital superintendents referred to find that the ward fires

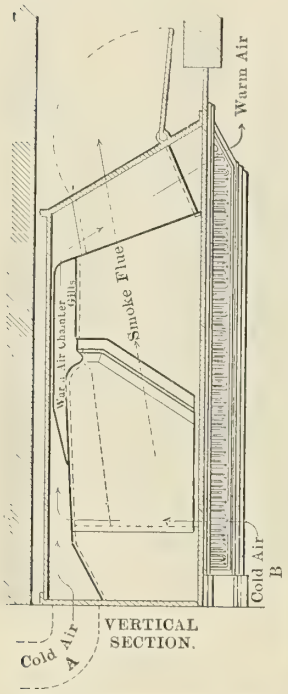


FIG. 48.—AIR-HEATING FIRE GRATE.

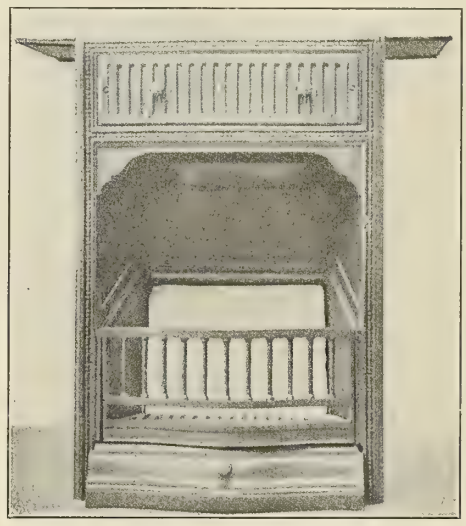


FIG. 49.—FRONT OF AIR-HEATING FIRE GRATE. WARM AIR ISSUES THROUGH REGISTER AT TOP.

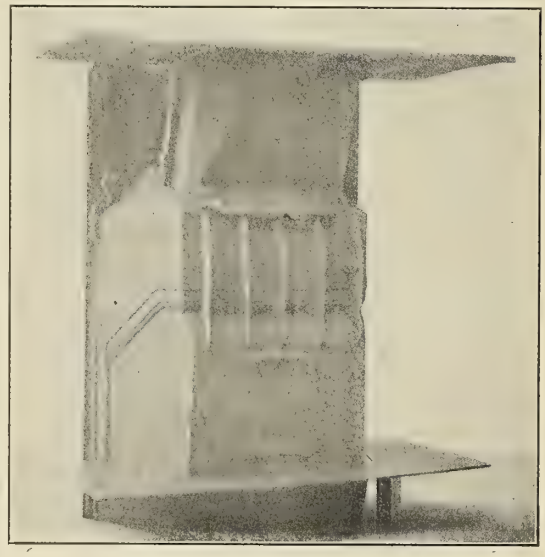


FIG. 50.—BACK VIEW OF AIR-HEATING FIRE GRATE.

possible to employ radiators in this way. But where doors are properly fitted, and where a supply of air is taken directly from outside of the room, it can always be warmed by passing it over the surface of a radiator. On shore the usual method is to fix the radiators close to the outer walls of the building; under a window is a favorite position. Holes are made in the wall, fitted with gratings of various forms, arranged so that the quantity of air passing through them can be regulated; and the air entering the room through these gratings is caused to pass over the surface of the radiator on its way, and therefore attains a certain temperature before it mingles with the air already in the room.

In a modification of this arrangement, the radiator is specially fitted, as shown in Fig. 52, with a plate on the inner side of the radiator tubes, which acts as a baffle to the air; and the air is obliged to pass over the full vertical and horizontal length of the radiator, and issues from it at a certain height above the floor. It is given a certain upward tendency, which causes it to mingle better with the air in the room, and produces very good heating effects. The question of the exit of the air in these cases belongs to the matter of ventilation and will be dealt with fully in that section. It may be mentioned here that the vitiated air of the room is usually carried off by the chimney, which still forms a part of the equipment of the modern house that is fitted with radiators, a grate also being provided that can be used in case of emergency.

On board ship, the equivalent of this would be similar to the arrangement suggested for the air-heating stoves. Ventilators bringing air from the topmost deck, or from the outside atmosphere, wherever it can be obtained without danger, would carry it by means of pipes down into the saloons, cabins, corridors, etc., and the air would then be directed over the radiators, in the manner described, and thence out into the rooms. The difficulty involved in these arrangements is, of course, that of providing the number of ventilators that would be necessary, since each radiator would require its own special ventilator, to provide its own supply of air, though it might possibly be arranged for one ventilator to supply air to two or three radiators. Unfortunately, under present conditions of seagoing ships, it does not seem practicable to employ the same arrangement for the supply of air as is used on shore, viz., for air to come in through the ship's side; though if valves can be arranged that will allow air to come in, and not water, when the ship is in a seaway, that portion of the problem would be solved. As will be explained in dealing with

have a good effect, and under the above reasoning they are scientifically correct.

HEATING THE AIR BY MEANS OF STEAM, HOT WATER AND ELECTRIC RADIATORS.

The next method of heating the air is by causing it to pass over the radiators that have been described, on its way into the room. It will be understood that there are two methods of arranging radiators in any room that is to be heated. One is by fixing the radiator somewhere near the middle of the room, and allowing the air of the room to be gradually warmed up by the convection currents that are set up and by the radiation from the stove. This method gives the engineer very little control over the temperature of the room, or of any part of the room, at any moment. If a door, for instance, is left open, and the passage or corridor into which it opens contains cold air, the heating within the room will probably be very poor, even with a considerable number of heating appliances, except in their immediate neighborhood and on the opposite side to that from which the draft is coming. The case is very similar to that of the coal fire with an open door or a very drafty door.

The other method is to place the radiators, or other heating appliances, in the path of the air that is entering the room and that is to be used more or less directly for ventilation. Where ventilation is effected entirely by windows, by open door, or, as is so frequent, by loosely fitting doors, it is practically im-

ventilation, something of the kind has been done and may possibly be extended.

The above remarks with regard to heating the air, by passing it over the surfaces of radiators, apply equally to steam and hot water, and to electrically heated radiators, and that, no matter whether the electric heating elements are of the luminous or non-luminous form. In fact, the majority of modern electrical convectors are arranged on those lines. The air of the room is heated by passing through the radiator, entering it at the bottom, passing upwards over the heating elements, whether they are lamps or resistance substances, and issues from the top of the apparatus at a considerably higher temperature. Fig. 53, taken from the catalogue of Messrs. O. C. Hawkes, Ltd., shows the idea. The air issues from the top of the radiator at a high temperature and gradually cools as it mingles with the air of the room beyond, raising the temperature of the latter air in the process.

It may be mentioned that one of the most successful forms

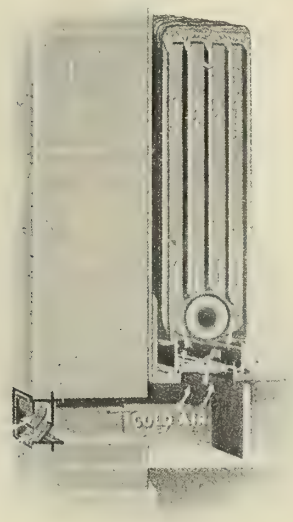


FIG. 52.—RADIATOR ON SHORE HEATING AIR DRAWN FROM OUTSIDE. NATIONAL RADIATOR COMPANY.

of gas-heated radiators, an American invention, operates on these lines. It stands out in the room in any convenient position, and air enters it from below, the products of combustion and warmed air issuing from below a plate on the top and mingling with the air of the room.

AIR-HEATING APPARATUS, PURE AND SIMPLE.

The air heating apparatus, pure and simple, really belongs to the domain of ventilation. In it the air for a whole building on shore is taken hold of, is cleaned in the case of towns where the atmosphere is foul, such as London and the manufacturing towns of the United Kingdom, and is warmed by passing over steam pipes, or cooled by passing over pipes containing either water or a solution of cooled brine, and delivered into the rooms to be warmed or to be cooled by ducts arranged for the purpose. The vitiated air is led away out of the rooms by means of other ducts, and is carried away to the outer atmosphere.

On shore, the usual method is to build a shaft on one side of the building, sometimes in the middle of the building, and carried up as high as convenient, and to a point where the air is as pure as it can be obtained. At the bottom of the shaft an entrance is made to the building by means of a large duct leading through a hole in the wall, and in this hole and duct are fixed the cleaning arrangements and a fan. On the other side of the hole, ducts lead to the different portions of the building, these ducts branching off to different sections of each portion of the building, and becoming smaller and smaller as the cubical space they have to supply becomes less.

The hole in the wall is usually occupied by the fan, and the cleaning apparatus is fixed on the outside of the fan, and also heating apparatus for the very cold winter months. A favorite form of cleaning apparatus on shore is a kaiar screen, stretched in front of the entrance to the building, and having

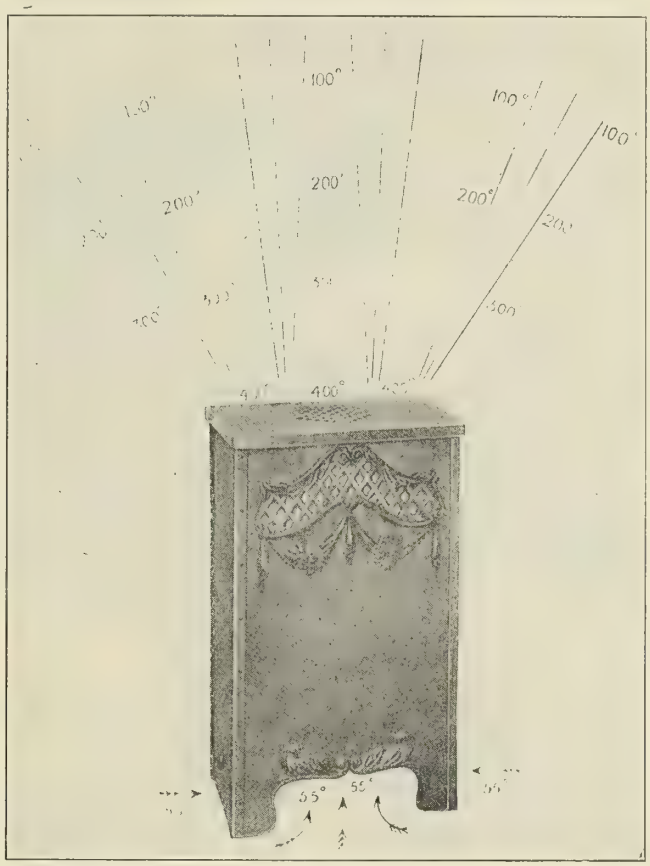


FIG. 53.—DIAGRAM SHOWING ACTION OF STOVE AS AIR-HEATER.

a stream of water constantly pouring over it, the screen being further cleaned by periodical flushes from a pipe above it, from which also the other cleaning water proceeds.

For shipboard work, particularly the modern ship that is divided up into so many watertight compartments, the problem is complicated by the fact that the deck has to take the place of the side of the building. Any air that is taken for ventilating or heating purposes must come from the deck, and any vitiated air that is expelled must be carried up to the deck. Any heating or ventilating appliance must enable the air to be carried separately into each compartment, and separately taken out of it, back to the deck. Though in the large, modern liners the deck is fairly large, it is not unlimited, and the provision of so many pieces of apparatus leading to different compartments and leading from them is sometimes a trouble, seeing that space has to be found for so many other things, such as boats, skylights, winches, etc.

On the other hand, a ship at sea has one very great advantage over a building on shore, especially a building standing in the middle of a smoky town. The air at sea is as pure as it is possible to obtain, and therefore, provided that reasonable care is taken to prevent the "stokers" from the chimney finding their way into the air inlets, and to keep the air inlets clear of outlets from lavatories, etc., any air inlet arranged on

a deck that is open to the atmosphere must provide absolutely pure air, and air fairly well charged with ozone. The passage of the ship through the water also necessarily carries off the vitiated air, leaving it behind, and, providing that care is taken that the vitiated air outlets are not placed, with reference to the air inlets, so that under any conditions of wind the vitiated air can find its way into the air inlet, the problem of inlet and outlet, subject to the question of space, is a very simple one.

Practically all that is required for warming the air supplying any part of the ship, say saloons, staterooms, officers' quarters, etc., are ducts leading from inlet apparatus on deck to the different parts of the ship to be warmed, and with a grid of steam pipes arranged in the path of the air to be

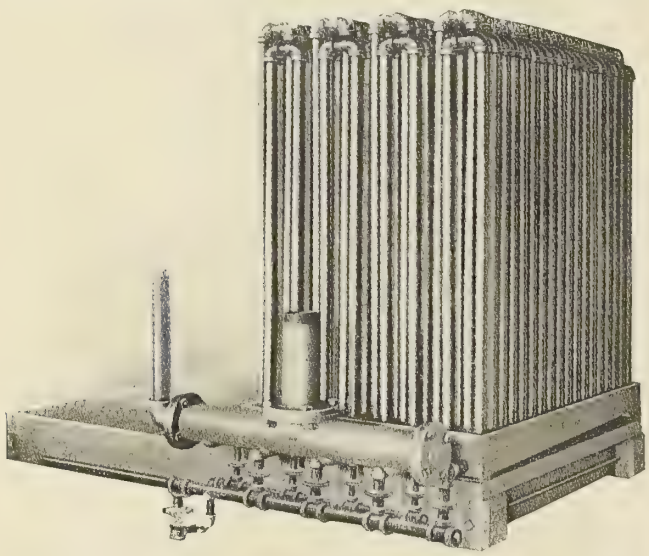


FIG. 54.—AMERICAN BLOWER COMPANY'S AIR-HEATER ON FERRY BOAT.

warmed (the grid being provided with a regulating valve, so that the pressure and temperature of the steam can be regulated at will), and some method of driving the air down below. Modern practice on board ship has settled down to the use of fans, and they are used sometimes for driving the air down below, sometimes for exhausting the vitiated air from below, and sometimes for both purposes.

The following is an account of some work done by the American Blower Company, of Detroit, Mich., on board the ferryboats of the Pennsylvania Railroad Company at New York. The air is heated by a bank of steam coils, on the lines of those shown in Fig. 54, which is fixed in the hold below the main deck. Fresh air is brought from above the main deck by means of a shaft, and is drawn over the steam coils by means of a fan on the other side of them, and when warmed is forced through a system of galvanized iron ducts into the passenger cabins, saloons, etc. The air enters the cabins, etc., through openings 3 or 4 inches in diameter, closed by louvre gratings, arranged for controlling the supply of air in the usual way. Owing to the limited space, the ducts were obliged to be somewhat small, and the velocity of the air consequently rather high. The heating apparatus was arranged in sections, so that the ducts leading to the different parts of the ship might be separately controlled. Other firms have arranged apparatus on something the same lines.

INLETS AND OUTLETS FOR THE AIR.

The cowl that was introduced a good many years ago for admitting air to spaces below deck has been superseded by short, vertical pipes, fitted with protecting hoods, the air passing up under the hood and down the vertical pipe, instead of passing into the mouth of the cowl, as was usual in older times. The same arrangement answers equally well for an outlet for the vitiated air. The principal requirements for inlets and outlets are that they shall be very strong; shall be firmly secured to the deck; shall not project above the deck more than is necessary to obtain a proper supply of air; shall not be liable to be easily carried away by a heavy sea, and shall not be in the path of any object that may break loose in a heavy seaway. Cases are on record in which the old form of cowl has been a serious danger to a ship.

One in particular that was mentioned at a discussion upon ventilation, at the Institution of Naval Architects, was that of a ship which was fitted with cowls, and which shipped a very heavy sea in a storm, the sea breaking in one of the hatchways on the fore deck, and the ship commencing to settle by the head. The hatchway was covered in a comparatively short time with tarpaulins and the pumps got to work, but it was found that the ship was still settling by the head, and eventually it was discovered that the fore trysail boom had carried away one of the cowls, and in the darkness (it was at 4 A. M.) this had not been noticed. The ship had a well-deck, and the sea had left a large quantity of water upon it, which was finding its way down through the hole left by the cowl.

(To be Continued.)

AFT END OF CRADLE WHEN HAULED UP TO HIGHEST POSITION.

A 2000-Ton Railway Dry-Dock.

The accompanying illustrations show one of the latest types of the larger capacities of railway dry-docks recently built by the H. I. Crandall & Son Company, of East Boston, Mass. This was constructed for the Richard T. Green Company at their repair and shipyard plant, Chelsea, Mass. The capacity of the dock is 2,000 tons dead weight, length over all 250 feet by 60 feet wide between the docking platforms. It is designed with especial regard to docking quickly and easily such craft as heavy dredges and large scows.

The cradle is built of timber, with the deck 1 foot higher than the surrounding water when hauled up to its highest position, and is fitted with twenty-six patent releasing bilge blocks, operated from a platform on each side by hand winches and chains. The keel blocks are of oak and spaced 6 feet between centers. The track rests on pile foundations, and is laid to a grade of 1 to 12. Including the machinery foundation, it extends the short distance of 455 feet from the street to the harbor line. The fact of successfully building, in this contracted space, a dry-dock of the railway type for vessels up

VIEW OF MACHINERY AND HAULING CHAINS—FORWARD END.

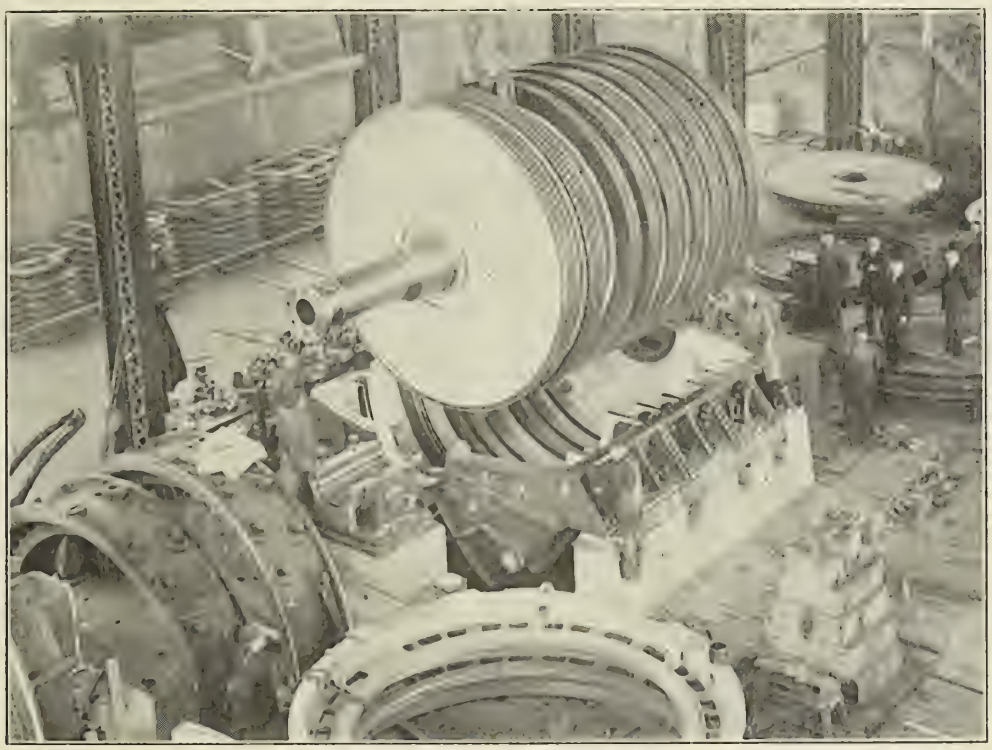
A Large Marine Turbine.

The photograph shows the lifting of a rotor from the motor casing of one of two 12-foot 7-stage Curtis reversible steam turbines under construction by the Fore River Shipbuilding Company, Quincy, Mass., for the Japanese government. These two turbines are to develop a collective brake or shaft horsepower of 24,000, with a considerable margin for overload capacity, and are to be installed in an armored cruiser designed for a speed of 23 knots. They were shipped early in April to Kure, Japan, by way of the Suez Canal.

Transportation by Water.

The United States Census Bureau has just made public a report for the year 1906 covering transportation by water for all American vessels of 5 tons and upwards. Comparison is made with the census of 1889 in many particulars, and a very great growth is shown. The figures for the recent year show a total of 37,321 vessels with a gross tonnage of 12,893,429 and a value of $507,973,121 (£104,381,602). The gross income was $294,854,532 (£60,588,616), and wages to the amount of $71,636,521 (£14,720,337) were paid to 140,929 employees. The number of passengers carried was 366,825,663, while the net tonnage (2,000 pounds each) of freight carried was 265,546,845. As compared with 1889 the gross tonnage had increased 54 percent; the value of vessels, 145 percent; the gross income, 92 percent; the wages, 73 percent; the number of employees, 24 percent; the number of passengers, 84 percent, and the freight tonnage, 104 percent.

The vessels were divided into three main classes, steam and gasoline (petrol) accounting for 9,927 vessels and 4,059,521 tons; the sailing vessels numbered 7,131, with 1,704,277 gross tons; unrigged vessels, largely in the nature of canal boats and barges, numbered 20,263, with a gross tonnage of 7,129,631. Of the steam vessels, 3,615 with a tonnage of 3,411,588 were devoted to freight and passenger service; 3,079 of 261,375 gross tons were tugs and towboats; 536 of 261,073 tons were



THE ROTOR OF A 12,000-HORSEPOWER CURTIS MARINE TURBINE SUSPENDED OVER ITS LOWER CASING.

to 260 feet length of keel, and drawing 16 feet mean, when light, shows its great adaptability under difficult conditions.

The raising and lowering of the cradle is accomplished by four heavy chains of special long-link type, attached to the forward part of the cradle runner through equalizing gear, thereby absolutely preventing unequal loading of the individual chains. These chains pass over cast-steel sprocket wheels, made to revolve by a train of machine-molded gears, operated in turn by a double-cylinder reversing engine; all parts are securely attached to heavy foundations. The time required for hauling out vessels, after centering them in the cradle, is 20 to 30 minutes on the slow speed, and 15 to 20 minutes on the fast; the latter being used for vessels of the lighter types.

The construction of the mammoth Hamburg-American liner *Europa*, in the yard of Harland & Wolff, Belfast, has been temporarily abandoned.

ferryboats; 2,176 of 82,275 tons were steam and power yachts; while the small balance is in scattering classification. Of the total steam and power vessels, those operating on the Atlantic coast and Gulf of Mexico numbered 5,413, with 1,457,894 gross tons. On the Great Lakes, including the St. Lawrence river, are 1,676 vessels and 1,915,786 tons. The Pacific coast, including Alaska, accounts for 1,066 vessels and 518,107 tons, while the Mississippi river, its tributaries and all other inland waters take up the balance.

Of the sailing vessels, 5,181, covering 1,672,862 tons, are devoted to carrying passengers and freight; and 1,594 vessels of 24,155 tons are yachts. Of the total, 5,920 sailing vessels, aggregating 1,132,905 tons, operate on the Atlantic coast and Gulf of Mexico, this being a decrease of more than 12 percent in tonnage in seventeen years. The tonnage on the Pacific is 305,283, while the Great Lakes and St. Lawrence river account for 265,571 tons.

Unrigged vessels include 2,237 canal boats of 303,581 tons, and 18,026 barges and other vessels aggregating 6,826,050 tons. On the Atlantic coast are 8,699 of these vessels, aggregating 2,260,622 tons. On the Mississippi river and its tributaries are 8,187 vessels, aggregating 4,265,740 tons. Of the ferryboats, 152 of 129,690 tons operate in the harbor of New York, and carried during the year 208,684,123 passengers. This is 63.1 percent of the 330,737,639 passengers carried by all ferryboats.

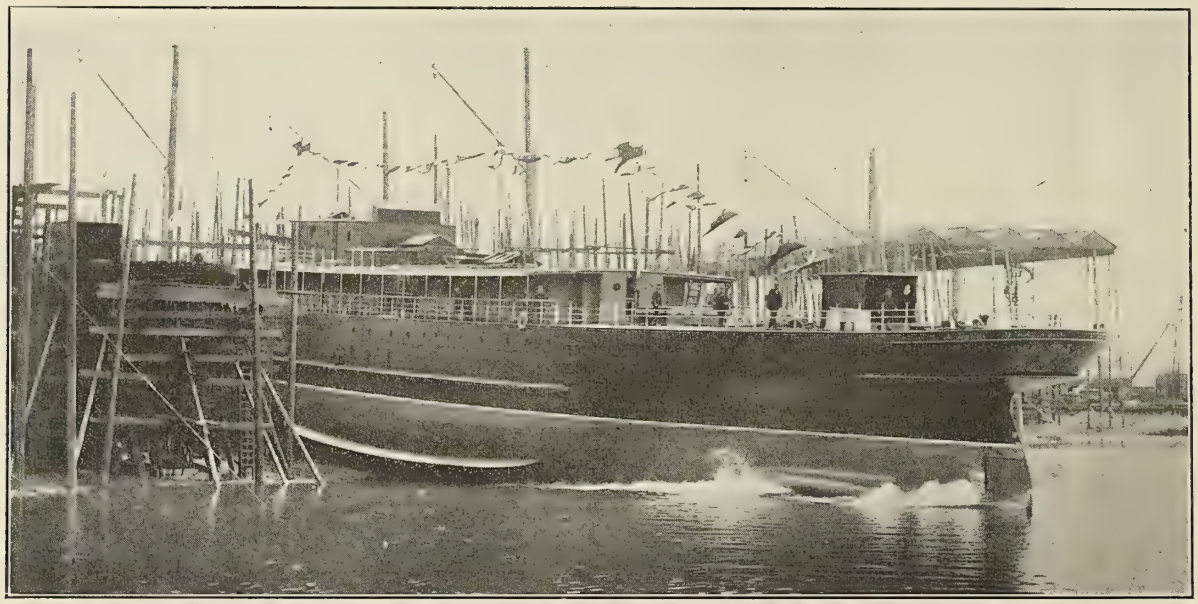
Of the total of all types of vessels, 1,979 of 3,276,723 tons are constructed of iron and steel; 35,247 vessels of 9,581,348 tons of wood; while the balance are of composite construction. The wooden vessels include canal boats and barges to the number of 20,077 and 6,991,233 tons. The iron and steel vessels include 1,674 steamers aggregating 2,916,517 tons. Wooden steamers account for 1,119,459 tons, and wooden sailing vessels for 1,470,656 tons. Both these latter figures have decreased since 1889.

The average size of all vessels was 345 tons in 1906 and 274 tons in 1889. Iron and steel steamers averaged (in 1906) 1,742 tons; iron and steel sailing vessels, 1,740 tons; iron and steel steam freight and passenger vessels, 2,889 tons.

The number of vessels propelled by steam is given as 6,765, with a gross tonnage of 4,008,431 tons, and 3,378,453 horsepower. Of these vessels, 5,160 have screw propellers; 1,055 have stern wheels; 543 have sidewheels, and the seven others have various modes of propulsion, including hydraulic. Gasoline propelled vessels number 3,155, of 50,998 tons and 73,204 horsepower. Screw propellers are fitted to 2,785 of these vessels; stern wheels to 351, and sidewheels to 19. The seven electric propelled vessels all have screw propellers, their gross tonnage being 92 and horsepower 88.

Of the total vessels listed the merchant marine includes the registered, enrolled and licensed sail and steam vessels, including fishing vessels. These aggregate 25,006 in number and 6,674,969 gross tons. Of this total, 9,500 are steamers of 3,975,287 tons, and 15,506 are sailing vessels of 2,699,682 tons. The tonnage employed in the foreign and coastwise trade in 1906 aggregated 6,602,510 tons, of which 928,466 tons (14 percent) were engaged in foreign trade and 5,674,044 tons (86 percent) in coastwise trade.

The report includes a large amount of other information in detail, including traffic through the St. Mary's Falls (Sault Ste. Marie) Canal, which is placed in 1906 at 41,098,324 net tons, as compared with 13,443,392 net tons for the Suez Canal, and 5,796,949 net tons for the Kaiser Wilhelm Canal. The canal on the Great Lakes is thus seen to have passed more than double the tonnage of the other two combined, in spite of the fact that ice closes the canal absolutely during about four months of the year. The freight shipped by water during the year 1906 aggregated, as above stated, 265,546,845 net tons (2,000 pounds). The largest single item was coal, which amounted to 49,109,605 tons. This was well distributed over the Atlantic coast, Great Lakes and Mississippi basin. The next item is iron ore, 41,524,102 net tons, of which more than 99 percent belonged to the Great Lakes. There were 30,029,515 barrels of petroleum shipped, of which more than half belonged to the Atlantic coast, and 10,929,939 barrels to the Pacific coast.



LAUNCHING OF THE JAPANESE STEAMER HIRAFU MARU AT DUMBARTON.

International Congress of Navigation.—On the 31st of May there will be opened in St. Petersburg the eleventh International Congress of Navigation, which will be in session until the 8th of June. This Congress has had sessions every year or two since 1885, and is devoted to a discussion of various matters affecting navigation and shipping generally. The program involves consideration of both internal and oversea shipping, with an exposition of designs, plans, charts, models, etc., relating to ocean and river navigation. The sessions will be held in the Conservatory of Music.

Japan's First Turbine Steamer.

BY BENJAMIN TAYLOR.

The first turbine steamer for the mercantile marine of Japan has been built by William Denny & Brothers, Dumbarton. The steel turbine steamer *Hirafu Maru* was the first of two vessels ordered by the Japanese States Railway for special service in the Tsugaru Straits. The launch was noteworthy as marking the introduction of the turbine to Japan, and also because the ceremony was purely Japanese. The stem of the vessel was covered by a profusion of ribbons and flags, and the draping of the launching platform showed a mass of gay coloring. As soon as the vessel began to move, Madam Yamanouchi, wife of Admiral Yamanouchi, wearing the dress of the Japanese court, loosened a cord at the bows, which liberated two white doves from a covering of silk, and at the same time produced a shower of confetti, which fell upon the party on the platform beneath the vessel's bows.

THE HIRAFU MARU ON TRIAL TRIP, ACHIEVING A MEAN SPEED OF 19.08 KNOTS.

The ship has a length of 280 feet, breadth 35 feet, and depth 21 feet 6 inches. She has been built under special survey of Lloyd's register, and in accordance with the requirements of the British Board of Trade and of the Teishinsho rules. The turbine machinery, which is supplied by Denny & Brothers, was designed to maintain a mean speed of 18 knots. On trial in the Firth of Clyde the speed obtained was 19.08 knots.

There is accommodation for first, second and third class passengers. The first class passengers are located in a deck house on the awning deck. Large cabins, having Pullman berths, are provided for ladies and gentlemen, in addition to the ordinary staterooms, and a special stateroom on the boat deck. The first class dining saloon is designed in the Louis XVI. style, and has a very high roof, the upper paneling of which is divided in leaded glass panels representing ancient shipping and other marine subjects. The ceiling, which is tastefully paneled like the rest of the apartment, is finished in white and gold. The sideboards and doors are of same design, the latter having the company's crest worked in leaded glass. The main vestibule is framed in light oak, dull polished. The second class passengers are located in a deck house abaft the boilers, both classes having sheltered promenades underneath the boat deck, in addition to which the first class passengers have a promenade on the boat deck itself. The third class passengers are accommodated in Japanese style at the after end of the main deck. Forward of this is accommodation for officers and engineers and the crew.

A large room is provided for mails, with suitable accommodation for the mail officers. Ample bathing accommodation is provided for all classes, as customary in Japanese vessels. The firemen and cooks, etc., are accommodated on the lower deck, which is fitted in the forward hold. Provision is made for a limited amount of cargo in the main and after holds.

The vessel is fitted with a balanced rudder of the builders' special type, actuated by a steam and hand steering gear, controlled from the flying bridge. The anchors, which are of the stockless pattern, are worked by powerful steam windlass, while a warping winch aft enables the vessel to be easily handled in harbor.

Institution of Naval Architects.

The spring meeting of the institution covered three days, April 8, 9 and 10. Fifteen papers were presented, many of them of unusual interest. The complete list follows:

Unsinkable and Uncapsizable Ships of the Goulaeff Form and System of Construction, by Gen. E. E. Goulaeff, F. R. S., N. A.

Modern Armor and Its Attack, by Capt. T. J. Tresidder, C. M. G.

Modern Torpedo Boats and Destroyers, by J. I. Thornycroft.

The Combination System of Reciprocating Engines and Steam Turbines, by Hon. C. A. Parsons, C. B., F. R. S., D.Sc., M. A., and R. Walker.

Speed Trials and Service Performance of the Cunard Steamer Lusitania, by Thomas Bell.

A New System of Ship Construction, by J. W. Isherwood.

The Heating of Modern Ocean Liners, by W. C. Wallace.

The Influence of Air on Vacuum in Surface Condensers, by D. B. Morison.

Note on the Use of Superheated Steam with Marine Engines, by M. Félix Godard.

Results of Further Screw Propeller Experiments, by R. E. Froude, F. R. S.

An Analysis of the Resistance of Ships, by Prof. William Hovgaard.

A New Method of Research Work on Fluid Resistance and Ship Propulsion, by Herr H. Wellenkamp, I. G. N.

Two Notes on Ship Calculations, by W. S. Abell, R. C. N. C.

Factors of Safety in Marine Engineering, by Prof. J. O. Arnold.

The Modern Developments of the Mariner's Compass, by J. C. Dobbie.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 5th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 1st of the month.

Construction Details.

About a year ago we obtained, through the courtesy of a correspondent, a large number of prints showing details of construction of various important features of both warships and merchant vessels. These include in the main such items as rudders, stern frames, spectacle frames and propeller struts, details of rams, bilge keels, steering gear and hawse pipes. While they represent practice of a somewhat restricted locality—the Pacific coast of the United States—yet they are up to date, and are of great interest because of the wealth of detail involved, and of the fact that it is often difficult, if not impossible, to obtain such items in connection with the description of a new ship.

Particularly difficult is it to obtain accurate drawings of this sort, and, for this reason, we feel justified in presenting the material in as much detail as possible. It is being divided up into three or four sections, the first of which, published this month, covers four typical rudders, three being on warships and the other on a large merchantman.

Shipbuilding.

Lloyd's reports indicate a decided decrease in the amount of tonnage under construction in British yards, as compared with the same period of last year. In spite, however, of a financial depression (more properly a financial stringency or tightness in the money market) in the United States, the report of the Bureau of Navigation, Department of Commerce and Labor, shows that during the nine months ended March 31, 1908, the tonnage of sail and steam vessels constructed in the United States has increased by approximately 25 percent, as compared with the figures for last year.

The report shows 775 vessels aggregating 353,763 tons, or an average of 457 tons per ship, as compared with 679 vessels and 280,291 gross tons last year, the average here being only 413 tons. Construction has increased both on the Atlantic and Pacific coasts and the Great Lakes. The figures for these three divisions may be summarized as follows:

	1907		1908	
	Number.	Tons.	Number.	Tons.
Atlantic	365	92,582	355	102,372
Pacific	119	16,400	170	32,961
Great Lakes...	72	167,105	111	214,885

The great number of vessels shown is accounted for largely by the fact that 667 this year and 593 last year were built of wood, and were of small size. If, however, we confine attention to steel steamers, the item of real importance in the returns, we find that the gain has been from 81 vessels, 232,264 tons, and an average of 2,866 tons last year to 107 vessels, 295,682 tons, and an average of 2,762 tons this year. Here again each main division has shown an increase, the greatest being that on the Lakes, where the figures are, respectively, 165,793 tons and 212,477 tons.

In addition to the construction of sail and steam vessels there were many unrigged vessels (canal boats, barges, scows, etc.) included in the report, the figures being for nine months last year, 258, of 64,217 tons, as compared with 246 and 65,511 tons this year.

The Development of the Modern Freighter.

We are describing this month, side by side, a half-dozen steel steamers intended primarily for the carrying of freight, built by various yards in Britain and on the continent, and constructed from a variety of designs, some features of which were unheard of a dozen years ago. In the modern development of this type of vessel the tendency has been all along to dispense with obstructions in the hold, leaving a large, clear space free for the stowage of either bulk cargo or of large sections of machinery and other freight, with large hatches for loading and discharging cargo, and with powerful machinery for use in this connection.

Among the most prominent features of ships built according to this new principle might be mentioned a general tendency to place the propelling machinery right aft, with a minimum length of shafting and a minimum disturbance of cargo space by shaft tunnel, machinery casings, etc. This tendency has been carried to its logical limit in the big steamers which have been constructed in large numbers on the Great Lakes of North America. Not only has there been left a clear hold, reaching in some cases to more than 400 feet in length without a single break, but the arrangement of hatchways has been so standardized, in connection with the loading and unloading devices of immense power located at the various ore and coal docks on the lakes, that a minimum of time is required for either operation. These hatches are spaced either 12 or 24 feet between centers, depending upon circumstances; their greatest length is athwartship, reaching in some cases two-thirds the breadth of the vessel; and as the unloading machines are also 12 feet apart, this makes it possible to bring the vessel to such a position alongside the wharf that a score or more of these machines may be operated at once and an immense cargo discharged in a time which, to those not accustomed to this method of doing it, must seem incredible. The largest vessels of this service can carry more than 12,000 tons of bulk cargo in the shape of iron ore or coal. This immense quantity can be loaded into the vessel in from one and one-half to two hours, and such is the celerity with which it can be discharged by the special appliances in use for this purpose, that not more than five or six hours are consumed in this operation.

Among the vessels described this month we find that considerable reliance for loading and discharging is placed upon devices carried by the vessel herself, consisting in the main of large cargo booms operated by powerful winches. In the very nature of things this cannot accomplish the result in anything like the small amount of time required by the vessels on the Great Lakes. On the other hand, with the great diversity of character of cargo carried by the ocean-going vessels, and the totally unsystematized arrangements at the various ports to which they carry this cargo, no such unloading devices as obtain on the large fresh-water freighters above mentioned would be possible.

In general structural arrangement the designs are somewhat similar. In each case there is a deep double bottom, upon which reliance is placed in large measure for strength and stiffness of hull. Associated with this we find heavy frames in the shape of webs, stiffened by longitudinal girders and by efficient and, from some points of view, enormous brackets or gussets. These latter connect the frames to the double bottom and to such deck beams as are used. The latter are of great individual strength, and occur only between hatches. As a general rule, heavy longitudinals run alongside the hatches, with short beams from these to the frames. In some of the cases under consideration this month we find that the triangular spaces outlined by the gussets are used as top side tanks for water ballast, the idea being to avoid the great stability arm occasioned by the usual arrangement of ballast tanks, thus making the ship much easier in a seaway and tending to decrease the stresses to which she is subjected when operating under this condition.

In the interests of clearness of cargo space, pillars or stanchions are almost entirely dispensed with, and where they are used they are commonly made of great individual strength and set at long distances apart. In these cases they frequently carry heavy longitudinal girders for supporting decks and adding to the general strength of the structure. Along the same general line we might mention the fact that lower deck beams are practically eliminated, there being nothing across the hold from the top of the double bottom to the under side of the main deck.

All of these innovations, so to speak, have come gradually, and as the result of years of experience, experiments and developments, and it may safely be assumed that most of them have come to stay. The result is a ship in which a maximum of cargo-carrying capacity is associated with a maximum facility for handling this cargo, and with a minimum "tare" represented by weight of hull. The whole development is along sane lines, and, while we may expect to see it largely amplified and modified as the years go by, both as to the character of the individual construction and as to the number of units to which this construction is applied, yet we believe that the general features have already been developed, and that the ultimate type, if such a type is coming, will embody most of the present characteristics.

The Art of Making Sails

One of our articles this month, from the pen of the maker of the sails of most of the recent successful defenders of the *America's* cup, is especially interesting in that it takes up the whole subject matter of the elements conducing to success in a suit of sails. He points out the fact, not generally recognized, that the proper placing of the sails on the vessel is every whit as important as their correct cutting and manufacture. Directions are given for taking care of this point in such manner as to enable the reader to readily make use of the accumulated experience of years in the handling of sails. The subjects of shrinkage and stretching are carefully considered, and the methods shown of making allowance for either in a new sail, the idea being to so adjust the sail that, after "weathering," it may be a perfect fit, with the correct amount of draft.

This article is to be continued through three numbers, and then to be republished in pamphlet form, for more ready convenience of users.

Progress of Naval Vessels.

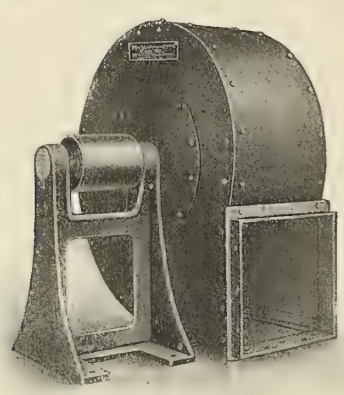
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Feb. 1.	Mar. 1.
BATTLESHIPS.					
Idaho	13,000	17	Wm. Cramp & Sons	95.9	97.25
New Hampshire	16,000	18	New York Shipbuilding Co.	97.8	99.3
South Carolina	16,000	18½	Wm. Cramp & Sons	36.4	39.05
Michigan	16,000	18½	New York Shipbuilding Co.	41.6	45.
Delaware	20,000	21	Newport News S. B. & D. D. Co	9.2	12.77
North Dakota	20,000	21	Fore River Shipbuilding Co.	17.5	21.4
ARMORED CRUISERS.					
North Carolina	14,500	22	Newport News Co	97.	98.
Montana	14,500	22	Newport News Co	93.4	94.96
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	96.2	98.38
Birmingham	3,750	24	Fore River Shipbuilding Co.	96.2	96.69
Salem	3,750	24	Fore River Shipbuilding Co.	93.9	94.31
TORPEDO BOAT DESTROYERS.					
Number 17	700	28	Wm. Cramp & Sons	4.5	6.88
Number 18	700	28	Wm. Cramp & Sons	3.8	6.8
Number 19	700	28	New York Shipbuilding Co.	5.1	8.4
Number 20	700	28	Bath Iron Works	2.5	5.38
Number 21	700	28	Bath Iron Works	2.5	4.91
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	99.	99.
Number 13	—	—	Fore River Shipbuilding Co.	.....	23.
Number 14	—	—	Fore River Shipbuilding Co.	.....	23.
Number 15	—	—	Fore River Shipbuilding Co.	.....	23.
Number 16	—	—	Fore River Shipbuilding Co.	.....	16.3
Number 17	—	—	Fore River Shipbuilding Co.	.....	7.5
Number 18	—	—	Fore River Shipbuilding Co.	.....	7.5
Number 19	—	—	Fore River Shipbuilding Co.	.....	7.5

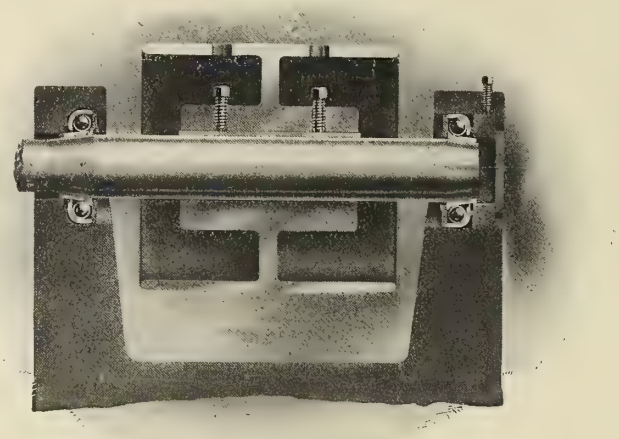
ENGINEERING SPECIALTIES.

Massachusetts Ball-Bearing Exhausters.

The ball-bearing exhausters now being manufactured by the Massachusetts Fan Company, Watertown, Mass., mark a distinct advance in fan-blower design. The bearings of the Chapman double ball type, with single ball races, are made of case-hardened cups forced into the hanger, and case-hardened cones forced on to tapered portions of the fan shaft. Between the two run hardened steel balls, separated by small ball idlers carried in light steel floats. The function of these floats is to keep the idlers in the center line of the larger balls, while the idler balls themselves eliminate the destructive grinding action of the load balls. The shaft may be readily driven out through the fan wheel, pulley and bearings; the taper contact between shaft and inner sleeve thus being easily broken. Such bearings have been run for months under various conditions without showing the slightest signs of wear or deterioration.



This type of fan possesses many important advantages over the older forms. In the smaller sizes the bearing supports form an inherent part of the hanger, making a very compact and rigid combination, while insuring absolute alinement of the fan shaft. Freedom from the necessity and expense of oiling is also secured. Such fans may be placed in the most conspicuous place without collecting dirt and dust due to escaping oil. Journal friction has been almost entirely eliminated. As a great and added advantage, these fans in the smaller

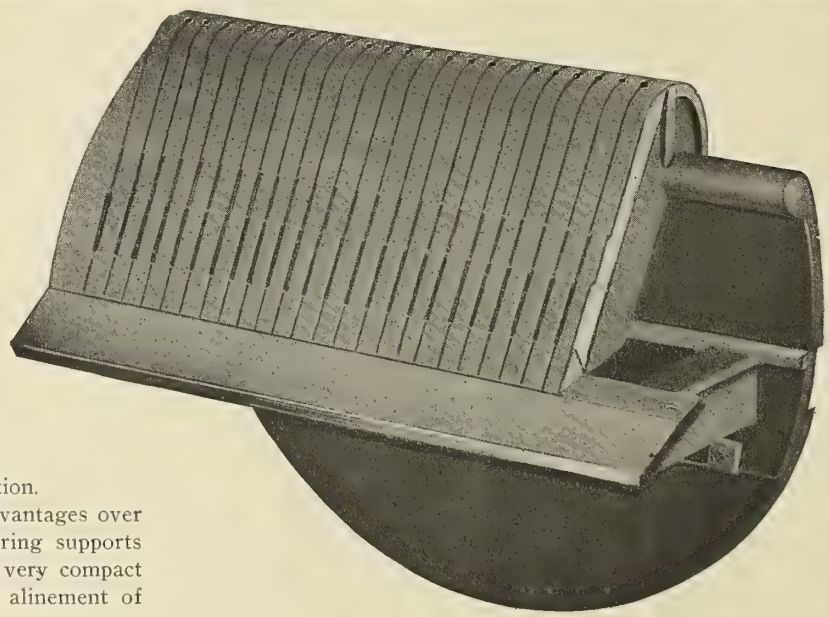


sizes (up to 60-inch shell diameter) are made universally convertible, that is, they may be adjusted to discharge in any direction. The purchase of an entirely new fan, or even the change of hanger, is thus obviated.

Comparative tests definitely prove the superiority of the ball-bearing fan over one fitted with plain babbitted bearings. A summary of such tests shows a decrease of about 10 percent in the requirement below that necessary with the older type. To provide against misleading results in these tests, both fans were previously run for several weeks, so that they presented ordinary conditions. Such economy in favor of the ball-bearing fan shows an approximate annual saving of 25 percent of the purchase price of the fan.

The Sturrock Furnace Bridge.

A device intended to promote complete combustion of fuel is shown in our illustration. It is designed for both marine and land purposes, and has been fitted to a very large number of steamers. The special advantages claimed for this bridge are: Increased facility in removing and replacing bridges



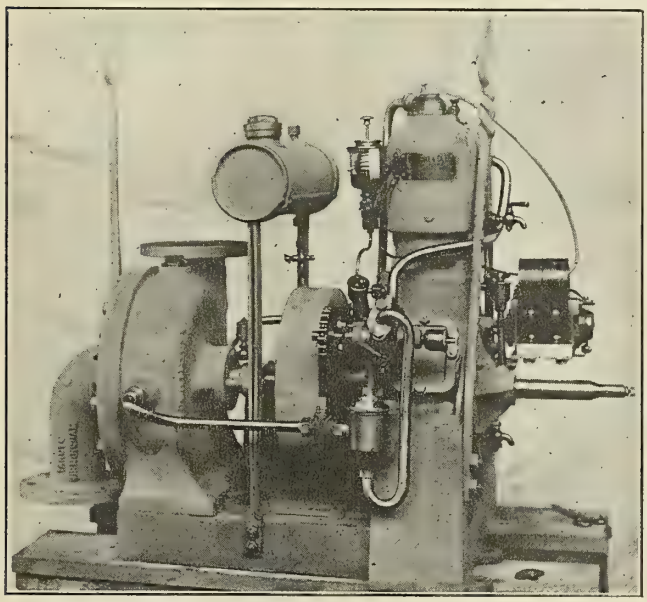
during inspection; facility in cleaning fires, due to such a construction of the bridge that clinker will not adhere to it; great durability, and a better combustion of fuel, resulting in greater economy, and a considerable reduction in the emission of black smoke.

The bridge wall is composed of cast iron bars with considerable air openings between. The dead plate, having openings through it, admits air freely from the ash pit to the back of the bars and through the spaces between to the fire, thus doing away with the usual pile of dead fire against the bridge wall. Air openings are also provided through the bars at the crest of the bridge, by which highly heated air is admitted to mingle with the gases from the furnace as they pass into the combustion chamber, thus effecting their complete combustion and preventing smoke.

This device is placed on the market by the Sturrock Patent Bridge & Engineering Company, Dundee.

A Small Pumping Set.

The illustration shows a 4-horsepower single-cylinder petrol (gasoline) engine, driving a centrifugal pump with 3-inch discharge, and capable of throwing 150 gallons per minute to a height of 20 feet. This set is placed on the market by J. W. Brooke & Company, Ltd., Lowestoft, and is mounted all on one bedplate, which forms a tank used for priming the pump.

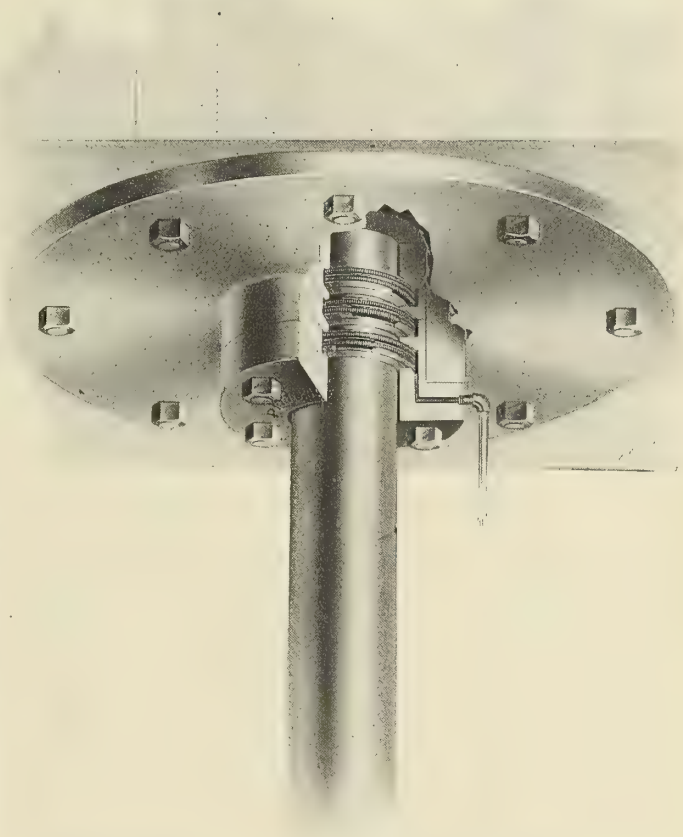


When the engine is running, the circulating water is drawn from one side of the centrifugal pump and returned to the other side, and in this condition the base is used as a silencer or muffler.

Ignition is by Simms-Bosch high-tension magneto, and the consumption of fuel at the full speed of 1,000 revolutions per minute is said to be only one gallon in 3 hours. Two slings are fitted for loading the outfit on a long pole, the entire weight being only about 500 pounds.

A Metallic Packing.

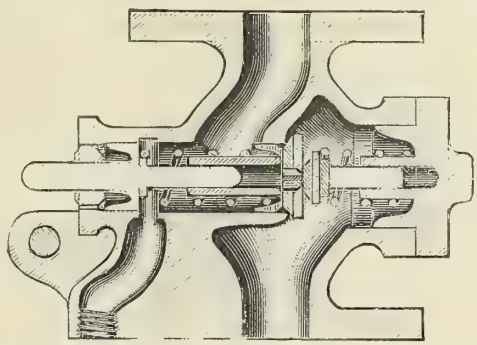
The Garlock Packing Company, Palmyra, N. Y., has developed a metallic packing of which our illustration shows a partial section. This is made extra strong for high-speed and high-pressure naval and other marine work, a special grade of bronze being used for the main wearing parts. Provision is made for collecting oil and water and discharging it through drain pipes, thus keeping the engine and its surroundings dry and clean. The packing, as shown, is fitted in three sections



with small glands, or "distance pieces," in between. The whole is then held in place, as usual, by a gland secured by studs. The packing is held tight against the rod by means of circular coil springs, which allow sufficient elasticity while still making a tight fit.

The Drainage of Steam Whistles.

Where the ordinary method of admitting steam into whistles and sirens of steam vessels is used, a great quantity of water, which has been condensed from the steam, remains in the pipes. Bends (where the water might collect) in the piping below deck are easily avoided; but the difficulty of preventing or getting rid of the condensation of steam in the piping above deck, where exposed to the cold air, has been a frequent cause of trouble. An ordinary stop valve is often fitted within easy



reach of the deck, but this is obviously dangerous, as there would be no time to open it should a sudden necessity to use the whistle arise.

A practical method of draining is employed on most of the vessels of the North German Lloyd Company, as well as on many ships in the German navy, the P. & O. Company, also a large number of other liners, passenger vessels and

private steam yachts, in the shape of a patent valve, which serves both as a stop valve and a whistle valve. This appliance, known as Moller's drain valve, is manufactured by the Combination Metallic Packing Company, Ltd., Gateshead-on-Tyne. It will be seen that by this arrangement no accumulation of water is possible; as when the steam is shut off from the whistle there is always a free passage for the condensed steam to flow away to any convenient receptacle.

The valve is fitted as close to the deck as possible, and is worked by a line led by a pulley to the bridge in the ordinary way. When the disk valve at right is closed, the piston valve at left is pressed back to allow a free drainage of the pipe through the port. On pulling the line, the piston valve first covers the drain, and then opens the disk valve. When the line is released, the disk valve is again closed by the steam pressure, and the piston valve is thrown back to reopen the drain. The instantaneous clear and full sounding of the whistle is thus rendered a matter of certainty.

TECHNICAL PUBLICATIONS.

Berechnung und Konstruktion der Schiffsmachinen und Kessel. By Dr. G. Bauer. Size, 5 by 8 inches. Pages, 820 + xxxvi. Figures, 623. Munich and Berlin, 1908: R. Oldenburg. Price, 24 marks (24/–).

This is the third edition of the work, and it has been thoroughly brought up to date by the addition of certain material on turbines and other items wherein large progress has been made since the publication of the first and second editions. The work is divided into eight main sections, of which the first includes the main engines; the second covers pumps; the third covers propellers and ship resistance; the fourth covers pipes used on shipboard for various purposes; the fifth covers boilers; the sixth treats of various devices for measuring; the seventh is a collection of items such as platforms, gratings, engine and boiler foundations, lubrication, disposition of ashes, etc.; while the eighth consists of forty tables of mathematical quantities, metric and English conversion units and various tables covering nautical practice.

The work is well illustrated, some half-tone engravings being printed on folding plates in order to give a large illustration, for the page would be too small for this purpose. Many line drawings are similarly placed, and the result is a thoroughly satisfactory volume from every point of view. With characteristic German thoroughness the matter is taken up from the mathematical point of view, beginning with the determination of cylinder dimensions, and carrying the reader through the various parts of the engine and its auxiliaries.

The second edition has been translated into English, and it is probable that the present one will be likewise treated.

Refrigeration. By J. W. Anderson, M. I. C. E. Size, 5½ by 8½ inches. Pages, 242. Figures, 87. London and New York, 1908: Longmans, Green & Company. Price, 7/6 net.

The subject is taken up from the point of view of heat and its abstraction or removal from the body to be cooled, and reference is made to a complete analogy to this manner of regarding heat in the case of water, which will readily flow from a high to a low level, but to be transferred from a low to a high level it must be lifted or pumped; work must be performed and energy expended. The amount so expended will necessarily depend on the quantity in question and the height through which it is raised. In the same way heat pumps (refrigerating apparatus) require the expenditure of energy, the amount depending upon the quantity and the difference between the first and last conditions.

The first six chapters are devoted to these elementary considerations of heat and its transfer; the properties of fluids and gases, liquids and vapors, and the laws of thermodynamics. In the seventh chapter refrigerants are discussed, the general types of machines and operations outlined, and tables given showing the various characteristics of different types of apparatus. The remaining five chapters are devoted to the substances used as refrigerants, to the making of ice, the construction and insulation of cold stores and miscellaneous uses and arrangements of refrigerating plants.

Of particular interest is the chapter on cold stores, showing the methods of insulating the walls, doors, floors and ceilings in such a manner that heat may be kept out to such an extent as may be required in any particular case. This section, as well as the others in the book, is illustrated by both half-tones and line cuts, showing details of construction. With regard to insulation, the cases of the *Lucania* and *St. Louis* are mentioned, in the former of which certain portions of the depth of insulation are taken up by sawdust backed up by boards, paper and hair felt; while with the *St. Louis* there is an air space between two sheaths of boards, the other materials being paper, ruberoid and granulated cork.

An unusually complete index, covering more than twenty pages, renders the work easy of access as a reference book, and adds to its value as an elementary text book.

Handbook for the Care and Operation of Naval Machinery. By Lieut. H. C. Dinger, United States Navy. Size, 4⅝ by 6¼ inches. Pages, 302. Figures, 134. New York, 1908: D. Van Nostrand Company. Price, $2 net (8/3).

The larger part of the contents of this work has already appeared serially in the *Journal of the American Society of Naval Engineers*. The present volume includes slight modifications and numerous additions to the material there published, and is placed before the public as a concise and simple description of the care and operation of naval machinery, on many points not largely discussed in standard treatises on the subject of marine engineering. The information has been obtained largely from first-hand experience, but free use is made of many authorities.

The work is divided into six parts and thirty-two chapters. The first part deals with the operation of naval machinery; the second with the care and overhauling of the main engines; the third with fittings and auxiliaries; the fourth with the care and preservation of subdivisions of the hull; the fifth with special auxiliary engines, such as steering gear, air compressors and blowers; while the sixth part deals with spare parts, tools and stores, and tests of machinery and piping.

The work is illustrated mainly by zinc engravings. A few half-tones are used for illustrating certain portions of the text, and there are a number of manufacturers' cuts, showing special devices of various types used on shipboard. The whole thing appears to be thoroughly practical, and doubtless will be found of much value to operating engineers, not only in the navy but also in the mercantile marine. It is, of course, specially designed for naval use, and based upon naval practice, but this does not render it less valuable in the merchant service.

Marine Boiler Management and Construction. By C. E. Stromeyer. Size, 6 by 9 inches. Pages, 404. Figures, 452. New York and London, 1907: Longmans, Green & Company. Price, $4 net (12s. net).

This is the third edition of a work which was issued first in 1893. It deals entirely with the return-tubular boiler, popularly known as the "Scotch" boiler, this type having stood the test of many years of operation. The main addition in this edition has been along the line of materials and better methods of working them, due to a better knowledge of their structures and elements. This includes a study of the microscopic structures of various steels, and also a study of gas analysis and its relation to the up-take and funnel.

The work is divided into eleven chapters, the last two of which summarize the boiler rules of Lloyd's Register and the

Board of Trade. The other chapters cover, respectively, boiler management, steam and water, corrosion, fuels and combustion, heat transmission, strength of materials, mechanics, boiler construction and design. The numerous illustrations are all in the nature of sketches, showing the various parts and the strains to which they are subjected and the methods of achieving definite results from given material. The subject of riveting comes up for extensive treatment under the heading of "Boiler Construction." A comprehensive index at the rear of the volume makes it easy of reference.

The Engineering Index Annual. Size, 6¼ by 9¼ inches. Pages, 435. New York and London, 1908: *Engineering Magazine.* Price, $2 (8s.).

This exceedingly valuable reference work is compiled from the Engineering Index, published monthly in the pages of the *Engineering Magazine.* The first four volumes of the series cover in each case a number of years, while this is the second annual volume. In each case the subjects are taken up under eight general classifications: Civil engineering; electrical engineering; industrial economy; marine and naval engineering; mechanical engineering; mining and metallurgy; railway engineering, and street and electric railways. Five of these eight headings are largely subdivided to make reference the more easy, and it may be stated in passing that the references are taken from some 250 technical periodicals published in half a dozen languages.

The section of particular interest to our readers is that devoted to marine and naval engineering, and covering seventeen pages of the work. Each article reviewed is given four or five lines, stating the general scope, indicating whether or not it is illustrated, the approximate number of words, and the date and place of publication. Not only is the article given reference of this sort, but the publishers hold themselves ready to furnish complete articles in every case, where not out of print.

The importance of such an index to an engineer can scarcely be overestimated. All articles of any importance appearing in the technical journals all over the world are placed on record in such a manner that they may be readily kept track of for any purpose at hand; and, of course, the record, being carried on from year to year, is in a measure self-perpetuated. Each new volume keeps the whole matter thoroughly up to date, indexing, of course, only such items as have appeared during the previous year.

Harbor Engineering. By Brysson Cunningham, B. E. Size, 6¼ by 9 inches. Pages, 283. Figures, 248. London, 1908: Charles Griffin & Company, Ltd. Philadelphia: J. B. Lippincott Company. Price, 16s. net and $5 net.

This is a work divided into ten chapters, of which the first is introductory and deals with the history of harbors and harbor works from the earliest times. The other chapters cover, respectively, harbor design; surveying, marine and submarine; piling; stone, natural and artificial; breakwater design; breakwater construction; pier heads, quays and landing stages; entrance channels, and channel demarcation.

The work is taken up in a very comprehensive manner, and is well illustrated by both sketches and half-tones taken from photographs and drawings. It covers, of course, the civil engineering features connected with the reclaiming of land; the dredging of harbor anchorages and channels; the deposit of material, both at sea after dredging and in position for the location of a pier or breakwater, and of all the various engineering features incident to preparing waterways and roadsteads for the safe use of shipping. A number of charts and plans of various harbors are given, showing examples of work actually accomplished or under way, while sketches are given also of many of the devices, such as cranes, hopper barges, etc., for carrying out work of this character.

The Steam Turbine. By Robert M. Neilson. Size, 6 by 9 inches. Pages, 604. Figures, 387; forty-six full-page plates; ten folding plates. London and New York, 1908: Longmans, Green & Company. Price, 15s. net and $4.20.

This is the fourth edition of a work which, appearing first in 1902, stands on record as the first extensive book on a subject now recognized as of very great importance. Much of the previous work has been completely rewritten and a great deal of additional matter, including seven entirely new chapters, has appeared since the third edition. As indicating the great increase in size of the work it might be mentioned that the first edition contained only 163 pages (each considerably smaller than the present) and 145 figures.

The aim throughout has been to render the subject intelligible to the average English-speaking operating engineer, whose training along scientific lines has not been extensive. The various formulæ employed have generally been arranged to be suitable for any system of units, but where clearness of effect could be gained by fixing the units, the usual British system has been adopted. The effort has been to combine in one connected treatment a discussion of the turbine historically, theoretically and practically, and in the latter connection the purpose has been to describe not only the principal parts of the leading types of steam turbines, but also the small details, which have such a large effect in determining the success or failure of the turbine as a whole.

The chapter of most immediate interest to our readers is the last one in the book, covering ship propulsion. This carries the reader through the main development, starting with the *Turbinia* of 1894, and culminating for the present in the *Lusitania* of 1907. This chapter, which is one of the most extensive of the entire work, covers the various arrangements for placing the turbines, and gives particulars of comparative trials between turbine and reciprocating ships. Both mercantile and naval vessels are described, as well as yachts, the whole being a complete résumé of the subject up to date. Attention has been confined almost exclusively to the Parsons type of turbine, although some of the others have been given brief mention. At the end of the volume is an appendix covering in categorical order the British patents relating to steam turbines up to the end of 1905. An index of sixteen pages completes the volume. The illustrations are uniformly good, though of the zinc rather than of the wax type, and are given in such profusion as to illustrate very nicely details and general construction of the turbine and its principal parts.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 401.—Will you give a formula showing the relative strength of a deck beam with curvature (or arched) as compared with the same beam which is straight between points of support? C. E. C.

A.—If the ends of the beam are so fixed that there is no hindrance to horizontal movement, the beam is no stronger when curved than when straight. As a matter of fact, it is slightly weaker, on account of a small thrust along the tangent line to the beam at any point.

If, however, all horizontal movement of supports can be absolutely prevented, then the curved beam partakes of the nature of an arched rib with fixed ends. If not too flat, it is then stronger than if straight, on account of the arch-action.

The deck beam of a ship is supported with some rigidity at its ends, but the elasticity of the vessel as a whole would probably place it somewhere between the two cases above mentioned. In any event, no formula is available, each special case having to be treated separately. If the deck beam were

considered as having its ends so fixed that a slight yield of the supports might take place, the beam would become a simple curved beam, and would have no more strength than the straight beam, if as much. I. P. C.

The reason for giving crown or "camber" to the deck beams of a ship lies rather in the ability of this form to throw off water than in any idea of increasing the strength of the beam. Beams below the waterline are commonly not curved.

Q. 402.—What is the approximate horsepower absorbed by the auxiliary engines in a large liner; merchant ship; ironclad; cruiser; destroyer and torpedo boat? Also the weight? V. C.

A.—As a general proposition the shipbuilder does not give out figures of this sort, particularly with regard to the weight. It is often possible to obtain the power of the auxiliaries in warships, from published reports, but in merchant vessels this is rarely available. As a single instance, however, we know that the electric plant on the *Lusitania* and *Mauretania* is capable of developing 1,500 kilowatts, or 2,000 horsepower. The power of the balance of the auxiliary machinery is not generally made public.

From various trial trips of American battleships we have constructed a small table showing the power developed by the main and auxiliary engines, the total and the percentage which the auxiliary figure bears to the total. Some of these trials were under reduced power, while others were full power trials.

	Main.	Auxiliary.	Total.	Percentage.
Virginia	22,501	967	23,468	4.11
Louisiana	20,442	908	21,350	4.26
Nebraska	20,947	964	21,911	4.4
Minnesota	19,896	676	20,572	3.29
Minnesota	14,554	562	15,116	3.72
Ohio	12,670	280	12,950	2.16

It will be noticed that there is considerable variation in the percentages, which is easily explainable. In the first place, under forced draft the blowers are exerting a much larger proportion of the total power than under other conditions. When the ship is steaming at a low speed, many of the auxiliaries are running at almost the power required for full speed of the vessel, thus increasing largely their percentage. Various other features enter into the problem, and no definite figure can be given from which to work in design. Each particular unit of the auxiliary machinery must be considered separately.

Q. 403.—How do you estimate the shearing stresses in the rivets of the longitudinal seams of shell plating on a large steamship? A paper read before the Institution of Naval Architects in 1899 gives the formula: $q = \frac{F \times m}{l \times 2t}$ G. B.

A.—The usual method is to follow the rules of the classification societies, which are based on years of experience. They are wholly empirical, and are not usually susceptible to mathematical treatment. We know of no reliable formula which would permit the shearing stress to be determined with any accuracy.

Q. 404.—Please give formula for approximating the horsepower of single, triple and quadruple expansion steam engines at various steam pressures. B. P.

A.—The general formula for horsepower is:

$$H = \frac{2\,p\,L\,A\,N}{33{,}000}$$

This takes care of one cylinder only, and gives the result in horsepower when p is the mean effective pressure; L is the length of stroke in feet; A is the mean area of the piston, and N is the number of revolutions per minute. For an engine of more than one cylinder, the same formula is used for each cylinder, and the sum taken for all cylinders.

If it is desired to approximate to the horsepower of a triple-expansion engine, knowing only the steam pressure at the throttle and not the mean effective pressure, a fair approximation may be made by the use of the formula as given, where A refers to the high-pressure cylinder, and p is the pressure at the throttle. The figure thus obtained, multiplied by a factor (approximately 0.53) and by the number of cylinders (by three only, if a triple-expansion engine, whether there are three or four cylinders), should give a result somewhere near the proper one.

To check this we might take the official trial trip of the battleship *Virginia*, which has a high-pressure piston 35 inches in diameter, with a stroke of 4 feet. The piston area is 962 square inches, the revolutions on trials were 130, and the steam pressure at throttle was 228 pounds per square inch. Applying this formula and multiplying by 6, to take account of two triple-expansion engines (there were in reality eight cylinders) we obtain 21,950, where the actual figure was 22,501 horsepower. It will be seen that this is sufficiently close for many purposes. This method cannot, however, be recommended, except where the required data for the more exact method cannot be obtained.

Q. 405.—During the severe zero weather of the past winter, the steam pipe leading to the whistle was always kept under steam to prevent damage. In spite of this precaution, the top half of the pipe would freeze, while the lower half would not. The pipe, which is covered with asbestos cork and canvas, is perpendicular from the whistle to the deck, except for a slight bend near the whistle. Under the deck there is a good incline to the valve on the boiler. Was this freezing caused by the condensed water at the end of the pipe being held up by the steam pressure? Or would the water, being heavier than steam, flow back to the boiler as the steam condensed? There was no bend to trap it. J. B. S.

A.—The probability is that the steam in the pipe was gradually condensed, due to the very low temperature of the outside atmosphere, and particles of water clinging to the walls of the pipe were frozen before they could run down to the boiler. The whole question, especially as to the point above which freezing occurred, and below which it did not, may be traced to a very delicate adjustment between the effects on the condensed water, thus running down the walls, of the heat from the steam within the pipe on the one hand, and the low temperature from outside on the other. It is possible that a continued freezing action of this sort might conceivably have filled the pipe with frozen condensed steam for some little portion of its upper length, in spite of the fact that all surfaces so covered were at the same time subject in a certain measure to the high temperature of the steam within the pipe.

Carl A. Creutz, formerly of the Fore River Shipbuilding Company, has taken the position of managing director of the Ochta Shipbuilding & Engine Works, St. Petersburg, Russia.

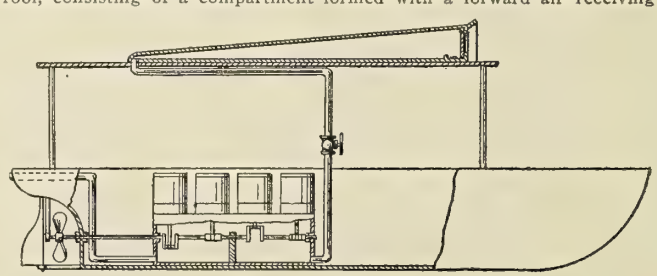
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

877,655. VENTILATOR FOR MOTOR BOATS. ABBOT A. LOW, HORSESHOE, N. Y.

Claim 2.—In a motor boat, the combination of an overhead awning or roof, consisting of a compartment formed with a forward air receiving



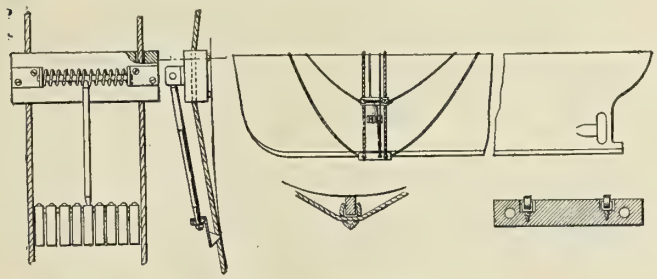
aperture, a flap arranged in conjunction with said aperture, a draining gutter under said flap, a conduit connecting the air compartment with the crank-shaft chamber of one or more hydrocarbon motors, and a discharge conduit connected with the crank-shaft chamber. Two claims.

876,470. MEANS FOR PROPELLING VESSELS. MARKUS F. MAUS, LYNBROOK, N. Y.

Claim 1.—As a means for propelling vessels, a piston mounted to reciprocate in a longitudinal channel of the vessel's hull, said piston comprising a blade pivoted to swing about an axis transverse to the path of the piston, and adapted to open as the piston moves in one direction, and to close as it moves in the opposite direction, a stop carried by the piston and mounted to turn about an axis transverse to the path of the piston and perpendicular to the first-named axis, to arrest the blade in the closed position either during the forward or during the rearward movement of the piston, and means for reversing the position of said stop. Fifteen claims.

877,745. VESSEL HULL SCRAPER. WILLIAM E. SCOTT, MONTREAL, CANADA.

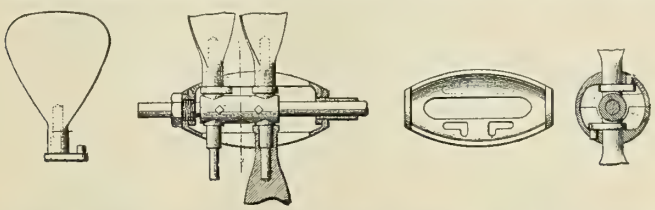
Claim 1.—In combination with a ship, a vertically and longitudinally adjustable block carried by the ship, bearings on the block, a rod rock-



ably disposed in the bearings, a spring coiled on the rod and having one end secured to one of the bearings and its opposite end secured to the rod, an arm secured to the rod, and scraping fingers supported by the arm. Four claims.

878,022. SPEED-CONTROLLING REVERSING PROPELLER. CHARLES F. ROPER, HOPEDALE, MASS., ASSIGNOR TO C. F. ROPER & CO., HOPEDALE.

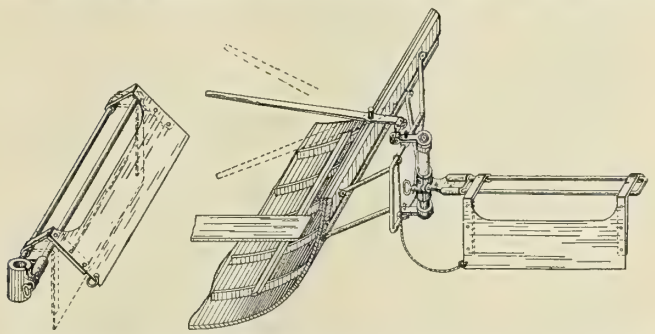
Claim 1.—A rotatable shaft, a hub fixed thereon and having rigid, radially extended and elongated bearing studs thereon in diametrically



opposite pairs, a propeller blade pivotally mounted on each stud, each blade having a deep socket extending well into the solid body thereof to receive the stud, and a single controlling means to effect equal and opposite angular movement of the blades of a pair, and also to vary the angularity of the blades of one pair relatively to those of the other pair. Eleven claims.

878,469. FEATHERING PADDLE ATTACHMENT FOR SMALL BOATS. WILLIAM RICKARDS, PORTLAND, OREGON.

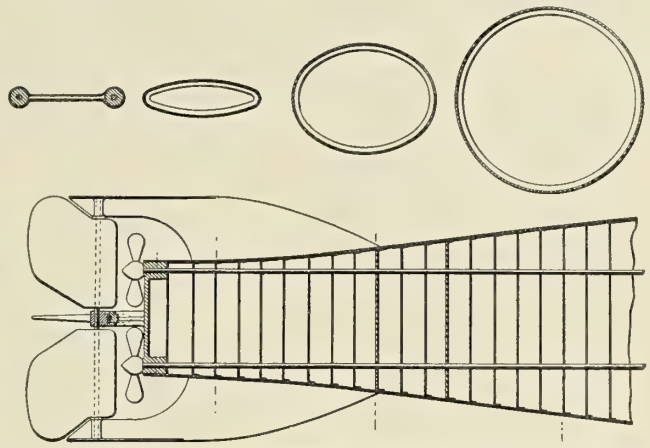
Claim 1.—The combination with a boat of a supporting frame affixed to the side thereof, a rod vertically pivoted in such frame, a bracket projecting horizontally from said rod, a dependent blade hinged to



such bracket, means restraining the blade to a perpendicular position on the forward stroke of the paddle, and allowing it to feather on the return stroke, a horizontal, pivoted handle bar and means connecting it with said pivoted rod, whereby the former is adapted to operate the paddle; the blade-supporting bracket being vertically movable on its supporting rod, so that the blade may be relatively adjusted to the depth of the boat in the water, and the parts being duplicated on both sides of the boat. Five claims.

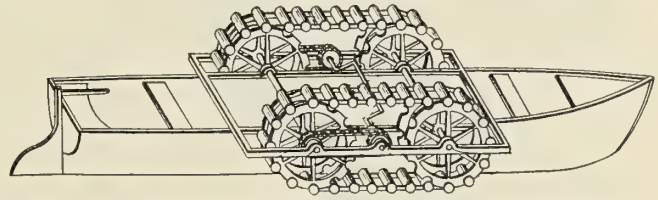
878,752. TWIN-SCREW SUBMARINE BOAT. L. Y. SPEAR, QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, A CORPORATION OF NEW JERSEY.

Abstract.—The object of the invention is to provide a submarine or submergible boat, having the usual substantially circular cross sectional construction, with twin screws. To effect this object and to avoid outboard bracket bearings for the screw shafts, the stern section of the boat is gradually reduced or diminished vertically, from the substantially circular cross section of the major part of the hull, so as to finally merge, through gradually flattening elliptical cross sections, into a stern frame having substantially parallel sides, within which frame are formed the end bearings for the screw shafts. Three claims.



879,689. PROPELLER. ALBERT STANDAU, TERRE HAUTE, IND.

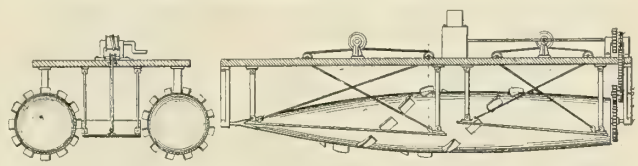
Claim 3.—In a propeller, an endless chain comprising a series of



elongated paddles, each having a groove near each end thereof, flexible means engaging said grooves for connecting said paddles together, flexible casings inclosing the greater portions of said paddles, and means for rotating said paddles. Six claims.

879,860. SPEED-BOAT. GEORGE A. FARRELL, CHICAGO.

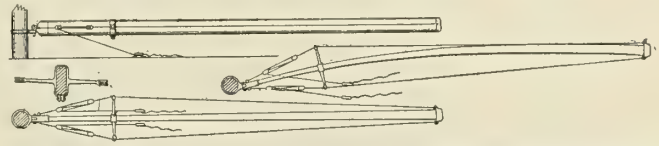
Claim 2.—In a boat, the combination of cigar-shaped revoluble bodies,



hydroplanes adapted to be secured between the bodies, a platform above the bodies and secured thereto, means for regulating the hydroplanes, and means for revolving the cigar-shaped bodies to propel the boat. Seven claims.

879,986. SAIL-BOOM. PERCY TATCHELL, LONDON.

Abstract.—According to the present invention, the sail is cut with little or no belly or flow, and is laced or otherwise fastened to the



boom, and the necessary belly or curve is imparted to the sail by bending the boom laterally to the required degree to give the best results under the conditions of wind prevailing. Six claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

19,247. SHIPS. PROPELLING BY SCREW PROPELLERS. A. M. MILLE AND C. A. F.-P. BIDET, HAVRE, FRANCE.

The tail shaft is mounted in a bearing adapted to turn about a vertical axis. The bearing is mounted in a spherical part provided with trunnions, the spherical part being secured between two portions of a stuffing-box having a gland. The stuffing-box is secured to the stern post and does not rotate. The thrust-block is mounted in a frame capable of rotation on trunnions. The vessel is steered by altering the angle of the propeller shaft to the center line of the ship. The packing of the gland is kept tight by springs, contained in hollow screws and acting on the sectors of a ring surrounding the packing.

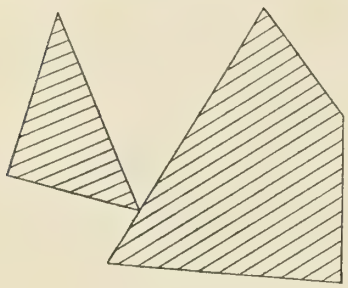
19,925. LIFE BOATS. C. LEHNERT, RUHRORT, GERMANY.

The hull is constructed in two portions hinged together at the stern, and united along the horizontal division by fly-screws passing through flanges. A lookout is provided at the bow of the boat. The vessel is propelled by paddle wheels actuated by any suitable means, and is steered by a rudder. Ventilation is effected through a pipe and a valve, which prevents ingress of water. The lower end of the pipe is screwed, so that a long pipe may be fitted in rough weather. The vessel is constructed of an aluminum alloy.

19,162. SAILS. G. J. TILLING AND T. T. CROWLE, SOUTHAMPTON.

Sails, of the type in which the seams are laid diagonally, for ships, yachts, etc., are constructed, in order that they may retain their shape, with the center of the width of the main cloth arranged, in the case of a mainsail or similarly shaped sail, in a direct line between the throat and clew, and, in the case of a sail of triangular shape, such as a jib or

topsail, at right angles to the stay, and extending in a direct line to the clew. The other cloths are fitted parallel to the seams of the main cloth.



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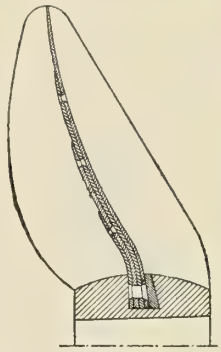


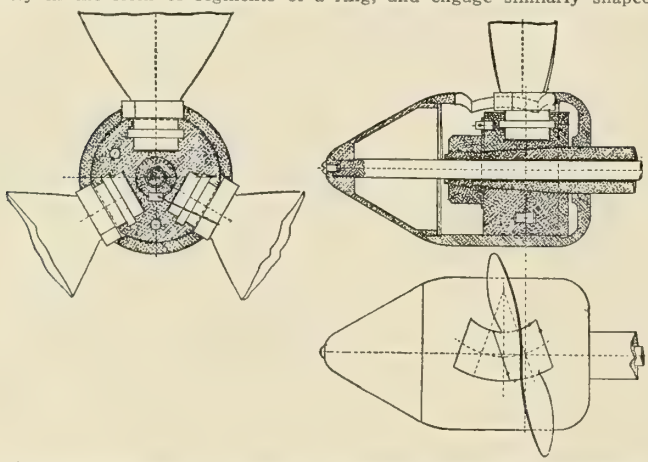
19,303.

19,303. SCREW PROPELLERS. L. GAYOTTI AND N. LAGANA, NAPLES, ITALY.

Propeller blades are built up of a number of sheets of metal, secured to each other by rivets of some soft malleable metal. The object of this construction is to provide a flexible blade. The thickness is reduced towards the tip by decreasing the number of sheets, and also the thickness of the individual sheets of metal. The blades are secured to the boss by keys.

19,911. SCREW PROPELLERS. J. ANDREWS AND D. CAMERON, KIRKINTILLOCH, STIRLINGSHIRE.

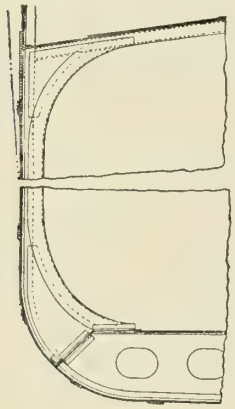
Relates to a reversible screw propeller for ships and boats, and of the type in which the blades may be turned axially by means of collars on the blade shanks working in curved openings in a sleeve surrounding the boss. Slots are formed in a sleeve provided with a cap, to which a rod, connected in a known manner with the reversing handle and passing through the shaft, is suitably secured. The slots are made preferably in the form of segments of a ring, and engage similarly shaped



collars on the shanks of the blades. The boss is secured to the shaft by a key and nut or otherwise, is provided with flats on its periphery adjoining the outer collars, and is preferably laterally divided in halves. The movement of the sleeve relatively to the boss is effected in the case of small propellers by hand gear, and in the case of large propellers by a direct-acting or other engine.

19,326. SHIPS' FRAMING. E. H. CRAGGS, MIDDLESBROUGH.

The decks and double bottoms are constructed in the usual manner, and the frame girders are built up of two or more angles, the reversed or inner member being bent inwards at its upper part and secured to the deck beam. The lower part of the same member is bent inwards and secured to the tank top by lugs. The upper and lower portions of the frame girders are fitted with plates, constituting webs, and providing additional strength at these points. The girders may be of other sections, divided at the upper and lower ends. The invention is stated to be particularly applicable to single-deck vessels, in which it is desired to omit a tier of beams.



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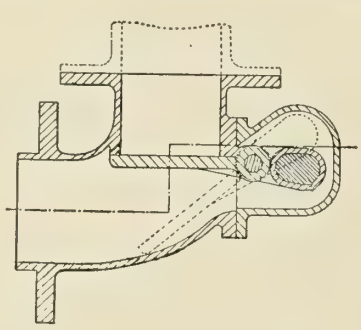


20,170.

20,170. SEA COCKS. H. McLACHLAN, RUTHERGLEN.

A storm valve for use on board ship in connection with the discharge pipes of baths, lavatories, water closets, etc., is made preferably in the form of a disk valve, carrying a balance weight and hinged to lugs on the casing. The valve seat may be removable. An opening having a removable cover secured by bolts, etc., enables the pivot pin to be withdrawn and the disk valve to be removed for cleaning or repair.

20,473. SCREW PROPELLERS; DRIVING GEAR. G. J. A. BOURDONCLE AND A. E. LEYMARIE, PARIS, FRANCE.

The screw propeller is operated from a motor through bevel gearing inclosed in a casing attached to the stern. The horizontal shaft is driven from a flexible shaft attached to the motor, and is provided with a sliding clutch operated by a hand lever, so that the shaft drives either of the bevel wheels, or occupies a neutral position. The vertical shaft is inclosed in a casing and drives a horizontal shaft, upon which the propeller is mounted, by bevel gearing. By means of the clutch, the vessel may be driven ahead or astern, or the motor may run light. The blades of the propeller are screwed into the boss, and secured by keys and screws, so that they may be set at any desired angle.

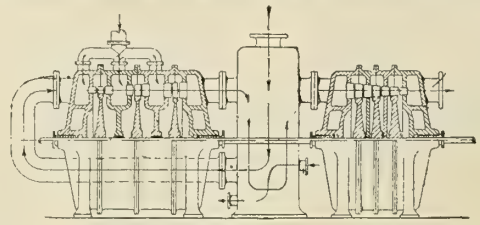
21,030. BOATS; LAUNCHES; PLANKING. S. E. SAUNDERS, COWES.

The inside framing of boats consists of a series of narrow strips of wood of convex or approximately triangular section. These strips may

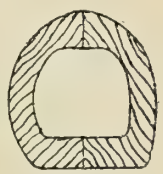
be worked in any direction, and are close jointed. The outside planking is similar to the framing, but is worked in a different direction. A layer of canvas, saturated with a waterproof solution, is fitted between the framing and the planking. The interstices in the planking formed by the sectional shape of the planking are filled in with composition and covered with canvas. In a modification, the inside planking is of the sectional form, and the outside planking is constructed with hollow and round seams, intervening layers of planking being wrought in a direction opposite to that of either the framing or the planking. Layers of canvas are provided, and the whole structure is firmly secured together.

21,063. ELASTIC-FLUID TURBINES. F. W. SEYBOTH AND E. K. A. BAUMANN, ZWICKAU, SAXONY.

A turbine driven by air at atmospheric pressure which is heated by combustion products is arranged with a regenerator between the turbine and a fan which draws the exhaust from the turbine, so that fresh air passing to the turbine is heated to a certain extent by the exhaust. The combustion product is supplied to the turbine at each pressure stage. A turbine, divided into pressure stages, is supplied with fresh air by a pipe. The supply of combustion products at each pressure stage is effected by a main pipe and branch pipes. On the turbine shaft is arranged a fan, which draws the exhaust gases through a regenerator and discharges them through a pipe into the atmosphere. The exhaust gases may be cooled by the introduction of water by way of a pipe, or by the direct introduction of water into the fan. The turbine is started by compressed air from a reservoir.



21,063.



21,084.

21,084. OARS. E. NORRIS, RIVERSIDE, LONDON, S. W.

Oars, sculls, etc., are constructed in two or more longitudinal sections throughout their entire length, and with hollow looms. The inner portions of the looms are hollowed out, and are then cemented together, and further secured by screws, etc.

21,222. SHIPS. BULKHEAD DOORS. J. E. B. WAKEHAM, ARGYLL ROAD, ILFORD, ESSEX.

Consists of an arrangement of handles and gearing whereby bulkhead doors may be lowered from a central station, or separately from the deck, or from a position near the door. A square shaft carries two cams, one of which puts a half-nut into and out of gear with the raising-shaft, while the other cam puts a corrugated brake into or out of gear with corresponding corrugations on the door. The shaft is operated by handles through a shaft and worm-wheel. Another shaft, operated from a central station, is geared with the first shaft by a clutch, which is put in and out of gear by a handle on the deck, or by a handle alongside the door.

21,298 SHIPS' HULLS, CLEANING. T. W. WILSON, DEVONPORT.

Apparatus of the type in which the brushes are rotated by screw propellers set in motion by the movement of a ship, or by streams or currents if the ship is stationary, comprises two propellers geared to a third propeller, the blades of which are arranged oppositely to those of the first propellers, and carry cleaning brushes or knife blades kept at a slight distance from the hull by means of short legs, provided with anti-friction rollers and fitted to the frame. Ropes are provided for moving the device over the surface of the hull, and the frame has eyes engaging guide-ropes.

21,352. SHIPS' CABIN LIGHTS. F. G. P. PRESTON, DEPTFORD, AND J. BURNS, BROCKLEY, KENT.

In a ship's scuttle or side-light, a tight point is made between the ring containing the glass and the frame, by means of an india rubber or other elastic packing ring, which is surrounded by a metal band, wire rope, or chain adapted to be shortened to compress the packing-ring. A lever, provided with a locking lever adapted to engage a fixed ratchet wheel, is mounted loosely on a pin in the frame, and may carry a latch fastening for the ring. The packing ring is contained in a groove in the frame. One end of the band is attached to the frame, and the other end is attached to the boss of the lever. At the point where the ends of the band cross, one part is slotted to receive the other part correspondingly reduced in width, or both parts may be halved.